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The Materials Outlook

At the moment the acute shortage of nickel is probably causing industry more concern than any other one material. This is despite reports that the amount of nickel being produced is almost sufficient to meet all current needs.

For example, supplies of chromium-nickel stainless steels are drying up because warehouse stocks cannot be replaced. Consequently, the straight chromium stainlesses will be offered for many applications where the 18:8 and other high nickel stainlesses are now being used. This will require a change in processing techniques in many cases.

Other efforts to avoid the use of high nickel alloys include the using of 9800 steels to replace the 4340 steels. Here again entirely new techniques will have to be learned.

Efforts to make our supplies of columbium cover the most urgent needs resulted in the recent order withdrawing alloys containing this element. It is likely that as other shortages appear to be reaching the critical stage, similar limitations will be imposed.

Columbium stabilized stainless steels which are now being restricted to high priority military and atomic energy projects will probably be replaced by the recently developed ELC (extra low carbon) stainless steels. These steels are welded without danger of intergranular corrosion.

Demands for titanium metal far exceed current supplies. Many potential uses are awaiting satisfactory processing developments. Plating, particularly, is needed to provide chromium wear resisting surfaces. Current plans call for a steady increase in titanium metal production, although for several years hence demands will continue to be considerably ahead of supply.

Although there has been no evidence of scare buying in magnesium, the indications are that supplies will be limited until government-owned facilities are operating. At that time, there will still be shortages of flat products due to insufficient rolling capacity.

Magnesium seems destined to play a greater part in any defense plans than was true during World War II. Present experiments are being conducted to produce entire aircraft wings as single castings or single forgings of magnesium.

(Continued on page 4)

The Materials Outlook *(Continued)*

The forging process involving a vertical hydraulic press would produce a stiffened skin 1/8-in. thick that would require no rivetted reinforcement. If the casting process works, it will ease demands on rolling and extruding equipment. There appears to be sufficient foundry capacity.

> Less and less will be heard about voluntary controls, voluntary allocations, voluntary means of distributing scarce materials. Official thinking has come pretty well around to the viewpoint that if the normal distribution of supply must be tampered with, a program of one kind or another, with accompanying official orders and directives, must be set up.

Chemicals, plastics, many other commodities aside from metals, have been more or less neglected by NPA while it concentrated its attention, with its still sharply restricted staff, to the scarce metals. Eventually NPA will go into industrial commodities other than metals, and as soon as it can get men to do the job.

> Aluminum procurement situation presents in capsule form an illustration of the complexity of spotting what is going to happen. Munitions Board wants aluminum of an unknown quantity for stockpiling. (Stockpiling of aluminum was decided upon after Korean war because (1) in case needs ran ahead of estimates, there would be something to take up the slack; and (2) if war damaged any plant, production of items using aluminum could go on uninterrupted from stockpile.)

The board asked for and got many offers to increase aluminum production capacity via guarantees, forward purchases, etc., from existing producers. General Services Administration got a firm offer from Canadians to sell the amount involved at an unrevealed price. GSA, by paying 2 to 4¢ above the market, could bring in some 270 million pounds annually of high cost production, where the higher price would be necessary to compensate for more costly electricity.

> Before decision is made as to which of the three means shall be utilized to get the aluminum from stockpile, the Government as a whole must balance, among other things, these considerations: Regardless of need for aluminum for stockpile, payment to domestic producers would be inflationary in the sense of putting out purchasing power for a dead commodity. The military services might prefer expansion of domestic capacity over any other method against the day of future production needs, since aircraft now use much more aluminum per unit than in World War II, and new uses in military items for aluminum not contemplated in War II (such as for parts of naval craft) are contemplated. Finally, should Canadian production be encouraged by purchases in the Dominion; and is this more desirable than beginning NOW to finance expanded U. S. production? Before this decision is reached and announced it is a good bet that not only GSA, National Security Resources Board, but Symington and each of the Armed Services will have a say.

News Digest

Embrittlement of Aluminum Alloys Caused by Soldering Investigated

In common with most other metals, some aluminum alloys are subject to brittleness and cracking as a result of penetration of solder during tinning. This problem has become particularly important in view of the increasing application of soldering to aluminum alloys. Results of an investigation of the problem by the British Aluminum Development Assn. were discussed in *Metallurgia,* Aug. 1950.

Soldering Method

Most recently developed method for producing wiped joints on aluminum-sheathed cable involves removal of the oxide film by filing or by phosphoric and nitric acids, followed by "tinning" by melting onto the surface a 90 tin-10 zinc alloy. The aluminum surface thus coated with tinning metal is readily soldered with 50 tin-50 lead alloy, and the joint can then be finished with a protective layer of resin or grease.

Not all aluminum alloys are embrittled by this treatment; pure aluminum is particularly free from this defect. Also resistant to embrittlement are aluminum-manganese alloys when annealed. Thus, certain alloys which have been locally cold worked should be annealed before soldering. Of susceptible materials, fully heat treated aluminum-magnesium-silicon and aluminum-magnesium-zinc alloys appear to be by far the worst.

Application Limited

The researchers conclude that the soldering technique described above is a practical one for many applications. It is especially desirable where the low temperatures experienced in soldering are advantageous. However, for many purposes where a durable joint under immersed conditions is required, gas welding and brazing will remain the principal methods of joining.

Tantalum Capacitor Developed

Corrosion resistant tantalum has been used in a new capacitor having electrical characteristics far superior to those of standard electrolytic capacitors, according to the Office of Public Information.

The tantalum capacitor can be operated from −75 to +400 F, whereas presently available electrolytic capacitors are limited to a temperature range from −4 to +185 F. Present electrolytic capacitors have a predicted shelf life of 12 to 18 months, while tantalum capacitors have an estimated shelf life of 5 to 8 years.

The capacitor was developed by P. R. Mallory & Co., Inc., under an Air Materiel Command contract.

Bonding Strengths Compared for Various Materials, Adhesives

Comparative data on the strengths of bonds between various chemical types of adhesives and representative engineering materials was presented at the Fall Meeting of the American Society of Mechanical Engineers in Worcester, Mass. The report was based on an investigation sponsored by the National Advisory Committee for Aeronautics and carried out by N. J. DeLollis, Nancy Rucker and J. E. Wier at the National Bureau of Standards.

Adhesives studied were polyvinyl acetate, cellulose nitrate, resorcinol resin, casein, gum arabic, natural rubber and Neoprene. Adherends were stainless steel, aluminum alloy, paper-phenolic laminate, glass, birch wood and hard rubber. Double-lap shear, tensile, long-time loading shear and impact strengths were the properties compared.

Tensile, Shear Strength

The investigators found that the tensile-adhesion and shear strengths for a given adhesive-adherend combination did not differ greatly except for wood and paper-phenolic laminates, which are nonisotropic. Highest values for these two properties were obtained with polyvinyl acetate and cellulose nitrate adhesives. With them failure occurred in the adherends, except in the case of the two metals. Strength values ranged from 1360 to 3600 psi. with metals and 400 to 2480 psi. with nonmetallic materials. Better correlation of shear strengths was found with moduli of elasticity than with dielectric constants of materials used in the various combinations.

Resorcinol resin and casein gave strength values ranging from 590 to 1940 psi. with hard rubber, paper-phenolic laminate and birch wood, but had little or no adhesion for glass or metals. Natural rubber, Neoprene and gum arabic adhered to all materials, but strength values were consistently low, ranging from 34 to 360 psi.

(Continued on page 8)

News Digest

Long-Time Tests

Comparative long-time load tests demonstrated the superiority of a thermosetting adhesive over a thermoplastic adhesive for supporting structural loads. The resorcinol resin showed no appreciable flow in supporting a load of 680 psi. for 6 months without failure, whereas polyvinyl acetate failed in 45 days under a 200-psi. load.

Rubber-type adhesives, which were weak compared with others in static load tests, were definitely superior in impact tests.

Better Castings Made in Graphite

Castings having improved mechanical properties as a result of the use of graphite molding material were reported by Vladimer A. Grodsky in *Metal Progress,* July, 1950.

The improved properties can be attributed to the increased chilling effect produced by graphite, which has the highest thermal conductivity of any nonmetallic substance. Aluminum alloys are reported to be particularly responsive to the change from ordinary molding sand to the graphite mixture, with increases in tensile strength running up to 22% and elongation up to 92%.

ASTM Statistics Papers

A booklet containing three technical papers and discussions on the application of statistics has been issued by the American Society for Testing Materials. These papers comprised a symposium presented at the First Pacific Area National Meeting, held in San Francisco last month. Copies of the 36-page pamphlet (STP 103) can be obtained from the ASTM, 1916 Race St., Philadelphia 3, at $1.00 each.

Not So Much Mystery

Back in July, this department included a brief story entitled "Spring Brass Stumps Metallurgists". It was reported that cartridge brass spring stock, cold rolled, increases substantially in yield strength if held at 300 F for some hours—a reaction similar to that of an age-hardening alloy.

It turns out that this phenomenon is not quite the puzzle it seemed to be. Several papers on the subject have been published in the last ten years by R. H. Harrington and his associates, of General Electric's Research Laboratory, and a patent on the treatment as applied to tin bronzes has been assigned to that company. This research showed that simultaneous increases in elongation, formability, endurance limit and electrical conductivity occur.

Warpage in Machining Solved

Solution of the problem of warpage while machining large aluminum alloy heat treated sections by setting up specifications on grain structure and grain size distribution has been reported by Harvey Machine Co., Inc.

Distortion is believed to be caused by non-uniform residual stresses from heat treatment associated with a heterogeneous crystal structure consisting of elongated grains varying in size across the section. The stresses vary in magnitude across the fibers and, as layers of fibers are removed in machining, stresses are relieved and movement occurs.

Work in cooperation with a major aircraft company indicated that extrusions produced under special metallurgical conditions showed no significant distortion after machining. These special conditions involve complete control of recrystallization in the extruded shape during the extrusion and heat treating cycle in order to produce a fine, uniform grain structure.

Continuous Casting Improved

Improvements in continuous casting equipment have been patented recently by N. P. Goss, Mayfield Research Laboratory, Cleveland.

Object of the improvements was to provide a continuous casting machine which maintains perfect alignment even though it may expand freely in every direction while being subjected to the thermal shock of liquid steel or nonferrous metals. Distortion of the mold is prevented and accuracy of mold section maintained despite the fact that the apparatus undergoes small mechanical movements.

An English steel company has been licensed to build the machines and exploit the process in England and other foreign countries. Several steel companies in the United States are investigating the method as a means of casting large ingots such as 30 by 4 in. at about 1500 lb. per min.

MPA Proceedings Available

Several technical papers on various phases of powder metallurgy are now available in a 92-page booklet released by the Metal Powder Assn., 420 Lexington Ave., New York 17.

This volume constitutes the proceedings of the sixth annual meeting of the MPA, held in Detroit last April. Cost is $2.50 per copy.

Titanium Carbide Materials Studied

Results of an investigation into the bonding of titanium carbide with various metals were published recently by the National Advisory Committee for Aeronautics in *Technical Note 2187.*

In the work done by W. J. Engel, it was found that only nickel, cobalt, chromium and silicon produced bonds with titanium carbide, with nickel and cobalt showing greatest penetration.

These metals were individually fused on solid high-density titanium carbide at minimum fusion temperatures in a helium atmosphere and at atmospheric pressure. Metals which did not bond under these conditions were: aluminum, beryllium, columbium, gold, iron, lead, magnesium, manganese, platinum, titanium and vanadium.

(Titanium carbide compositions bonded with nickel and cobalt have been discussed previously in MATERIALS & METHODS, May 1950, pp. 59-63.)

Literature Survey Provides Data on Deep Drawing of Nonferrous Metals

Deep drawing of nonferrous metals was the subject of a literature review by Marjorie Whitaker, of the British Nonferrous Metals Research Assn., published in *Sheet Metal Industries,* Sept. 1950. Following is a summary of those sections of the report which cover the deep drawing characteristics of specific groups of nonferrous metals.

Aluminum

Principal difficulties encountered in the deep drawing of aluminum are the fouling of steel tools, puckering and wrinkling, critical-strain grain growth, and a natural lag in recrystallization, coupled with rapid grain growth once recrystallization has started. Stretcher-strain markings sometimes occur. Heat treatable alloys can be pressed to a moderate depth, and the technique must be such that the properties of the alloy are not destroyed. Aluminum has the advantage of a low rate of work hardening, which decreases as the amount of deformation is increased; furthermore, the influence of average grain size seems generally to be less pronounced than in many other metals (average grain size from 0.035 to 0.050 is recommended for drawing). Aluminum-magnesium alloys, particularly those containing 3 to 4% magnesium, combine good pressing properties with medium strength and high resistance to corrosion. Age hardening alloy pressings are popular because of their high strength.

Chief precautions required in connection with drawing aluminum are: (1) The metal is allowed to flow as freely as possible in the press; (2) a high standard of cleanliness is maintained because of the particularly harmful effects of abrasive particles in contact with aluminum during pressing operations; (3) in the case of commercial-purity aluminum, sheet of hard temper is frequently used in order to avoid critical-strain grain growth; (4) intermediate annealing is often omitted for the same reason; (5) for the final anneal, uniform heating is essential, and for best results pressings are heated as quickly as possible and annealed the minimum amount for complete recrystallization; and (6) the finished shape is sometimes coined between suitable dies under a drop-stamp for the double purpose of removing puckers and wrinkles and sizing the shape.

Precipitation-hardening alloys require special care in the press shop because of their critical heat treatment. They are pressed while they are in the soft condition, which follows solution treatment and quenching. Those which age harden at room temperature are pressed within a few hours or retained in a soft state by means of refrigeration, while those which are hardened by heat treatment at elevated temperatures can be kept longer before pressing as they retain their softness for longer periods at room temperatures. These alloys do not have excellent pressing properties because of low ductility, but for relatively small draws they are satisfactory. They are often pressed in clad form; this makes it necessary to avoid scratching the clad layer and also to restrict the number of anneals and re-solution treatments on account of diffusion of elements into the coating.

Most successful way of combating "spring-back" experienced with age hardening alloys seems to consist of taking the pressing almost to full depth under conditions of easy flow of metal through the blankholders, then tightening up the blankholders to prevent further slip while the punch is taken to the bottom of the stroke.

News Digest

Magnesium

Alloys containing 1½ to 2% manganese, possibly with the addition of 0.5% cerium, are the most suitable magnesium alloys for deep drawing. Alloys containing aluminum and zinc are also used. Chief change in technique compared to aluminum alloys is that operations are carried out at elevated temperatures. Working temperatures are determined by composition, temper and thickness of sheet, depth of draw and radius of corners. Hard-rolled sheet can be given a moderate amount of shaping, and the temperature of drawing is usually between 300 and 480 F. Temperature is kept as low as possible to avoid loss of mechanical properties. Annealed sheet is usually pressed at a temperature within the range 480 to 660 F.

Metal is allowed to flow as freely as possible, though speeds recom-

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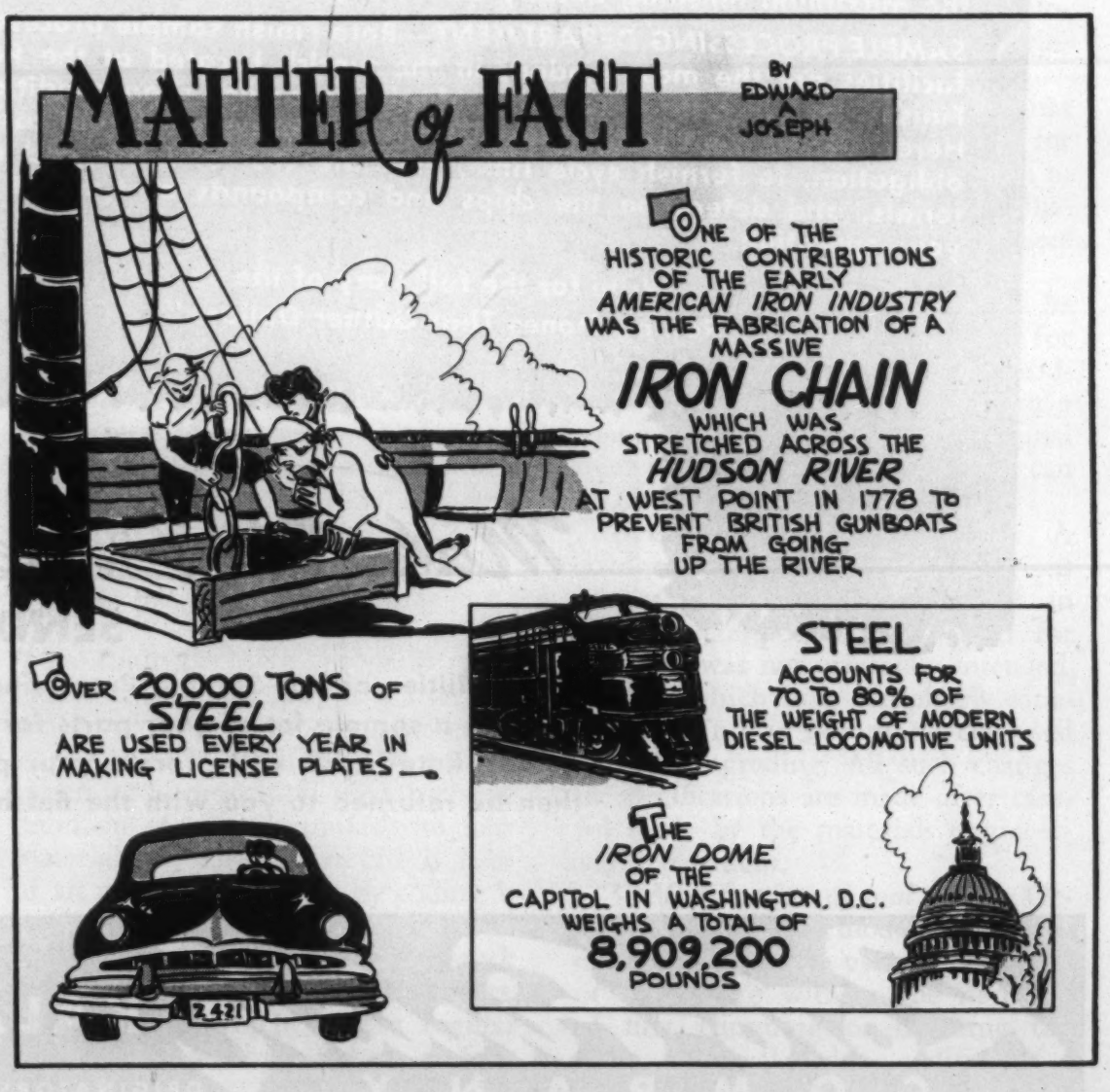
MATTER of FACT
BY EDWARD A JOSEPH
ONE OF THE HISTORIC CONTRIBUTIONS OF THE EARLY AMERICAN IRON INDUSTRY WAS THE FABRICATION OF A MASSIVE IRON CHAIN WHICH WAS STRETCHED ACROSS THE HUDSON RIVER AT WEST POINT IN 1778 TO PREVENT BRITISH GUNBOATS FROM GOING UP THE RIVER
OVER 20,000 TONS OF STEEL ARE USED EVERY YEAR IN MAKING LICENSE PLATES
STEEL ACCOUNTS FOR 70 TO 80% OF THE WEIGHT OF MODERN DIESEL LOCOMOTIVE UNITS
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2421

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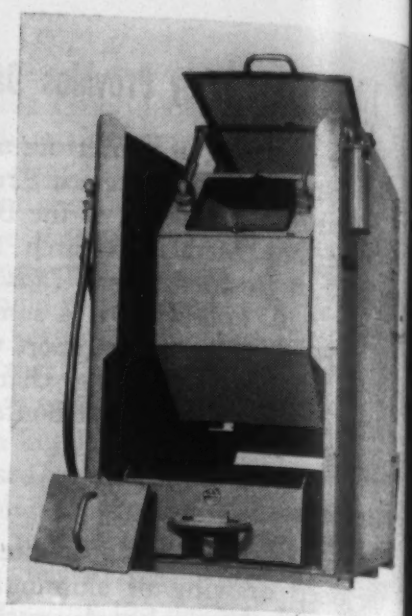

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Wise Use of Waste Materials Results in Significant Savings

by JOHN D. COLEMAN, Material Utilization Dept., Frigidaire Div., General Motors Corp.

General Motors plants have established comprehensive programs for reclaiming waste stock from metal-working operations and for salvaging rejects and obsolete parts.

• A FACT FREQUENTLY overlooked in industry is that the average loss of sheet and bar stock used in the fabrication of products may be from 20 to 40%, with extreme cases as high as 60%. This loss is made up of shearings, skeletons, offal blanks, trimmings, bar ends and scrap of faulty parts. In 1938 General Motors plants undertook programs designed to collect information on this situation and work towards a reduction of this loss.

The function of the Material Utilization Dept. at this division is not only to set up the productive standards of form, size and weight, but to see that the maximum use is made of the material available. This requires close cooperation with product engineering, material engineering, material control and production as well as tool planning and design departments.

Materials that can be saved by a waste material program have several origins as follows:

1. *Shearings.* These are cuttings from sheet stock of steel, brass, aluminum, etc., segregated as to specification and thickness but of variable width or length, so that they may require additional shearing or die changes for their utilization.

2. *Punch press offal.* This consists of slugs or blanks produced as a by-product of press operations on sheet stock. Since they are of uniform size, they are frequently adaptable to shuttle or magazine feeding in the production of other piece parts.

3. *Salvage materials.* These may be (1) rejects of materials, (2) formed piece parts from which a usable area can be recovered, or (3) obsolete piece parts or sub-assemblies.

How the Program Works

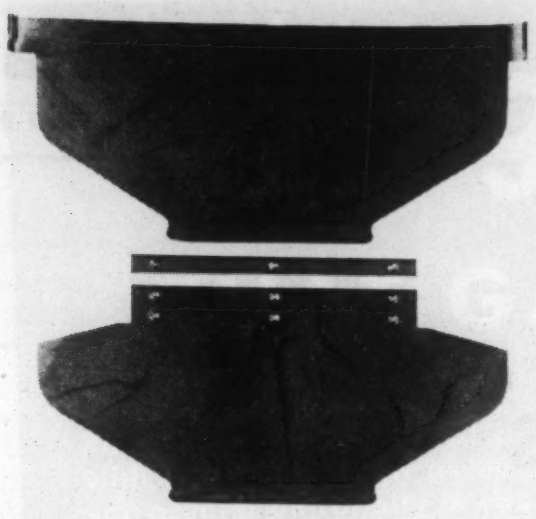
A comprehensive program provides for setting aside the above materials or items, properly segregated as to size and identified as to specification or composition, and carrying them on inventory similarly to new materials or parts. A record is kept of all utilizable material by coding it in the company's inventory lists in a special way. Regular production stock is identified by numbers of five digits. Offal blanks, which have a regular form, are coded by numbers of four digits, and shearings, which are irregular in size, are listed by numbers of three digits. A glance at the lists can therefore pick out the class of material to which the pieces have been assigned, and the number provides the remainder of the identification.

The Material Utilization Dept. has the responsibility of finding uses for as many of these items as possible in regular production or in non-productive applications. The search for uses takes several directions:

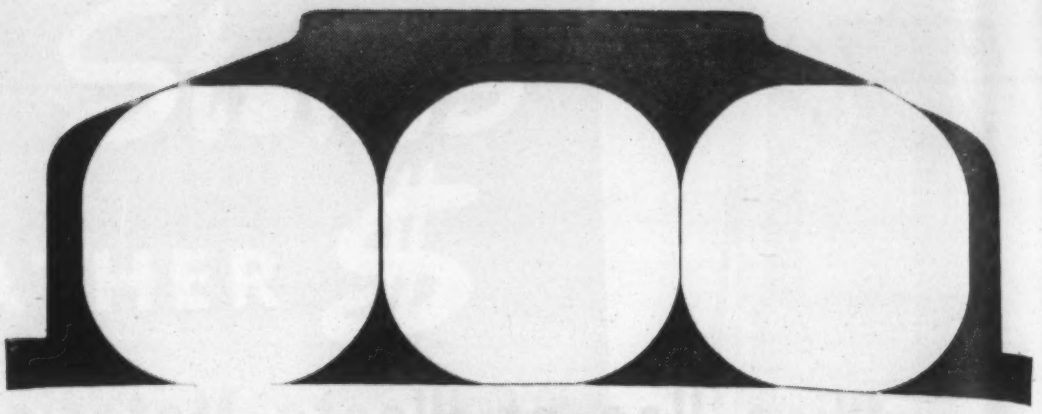
1. *Change in design.* This may be a change in the design of the part for which the material is being considered, or occasionally it may mean a change in the design of the original item so that a more usable offal can be obtained from it.

2. *Change in specifications.* A change in composition specifications can at times permit the use of an alloy or composition in a part for which it was not originally intended, but for which it is completely satisfactory. This is not to be confused with downgrading. All such changes in specifications are made after careful study by the materials engineering department.

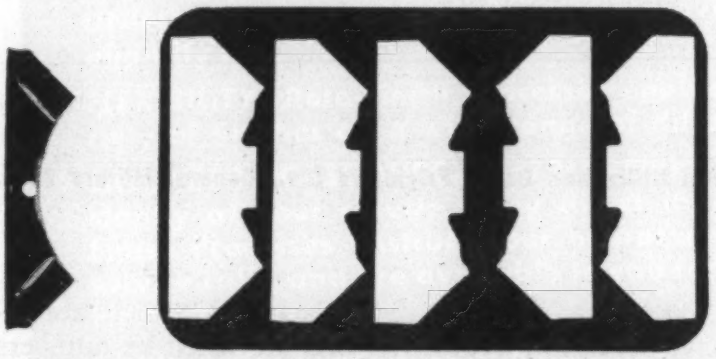
3. *Modification of tool design.* Occasionally a slight modification of a die will permit the use of a shearing or offal piece without the necessity of first trimming or blanking the piece. Removal and/or addition of a



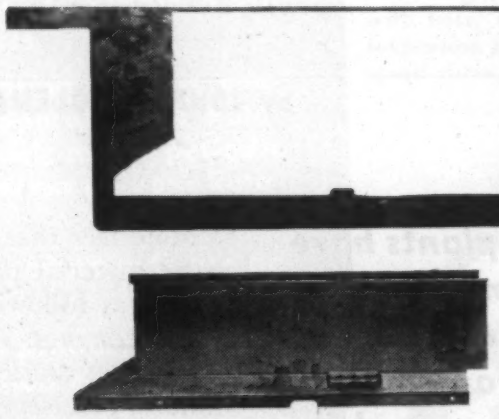
Blanking press offal from center horizontal panel of refrigerator (top piece). A refrigerator hydrator support retainer (lower piece) is made from this waste material.



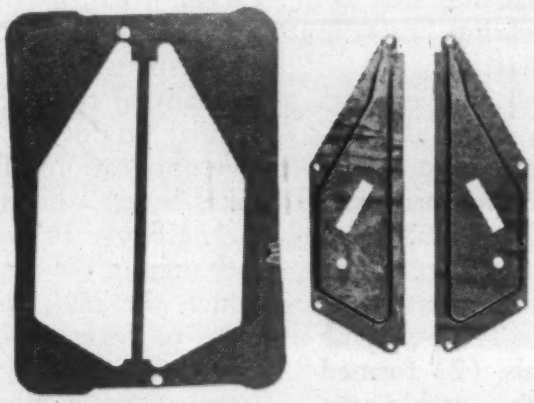
Gussets for refrigerator food compartment doors are made by blanking out disks from the waste piece as shown, and cutting each piece into quarters.



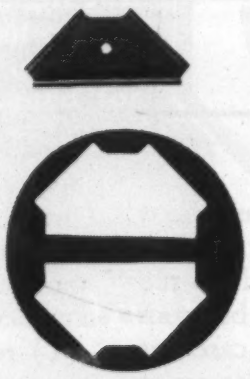
Gussets for a washer cabinet top were blanked from this washer rear panel offal. The 19-gage enameling iron was accepted as a satisfactory replacement for the 16-gage material formerly used.



A switchboard shield of cold rolled steel is made from this refrigerator back panel offal.



A range frame offal piece provides two gussets.



The slug from a range top yields two bulkhead clamps for a washing machine.

set of locating pins may be the only change required. More extensive changes must sometimes be made to permit use of a piece of gage different than that for which the die was intended.

4. *Repair of rejects.* This is a field for which generalization is impossible. A study of the reasons for rejecting a piece or a sub-assembly will frequently indicate how a repair can be made that will produce a completely satisfactory part, without running costs too high, thus saving the value of the material in the original piece plus the cost of the work already done upon it.

5. *Adaptation of obsolete parts.* Parts of satisfactory quality made obsolete because of a change of design can frequently be adapted or modified to fit elsewhere in productive service. When the change in design has eliminated some small item from the product, it may still be suitable for use in the maintenance department.

One of the most important steps in a materials utilization program is to develop a pattern of thinking, both in the engineering department and in the plant, that will tend toward the maximum utilization of all materials. Press operators must be persuaded to think of offal as good and potentially usable steel, and so to avoid battering or cutting such offal unnecessarily. In the engineering and tool planning departments the thinking must go back to the original design of the parts; such design as would limit the utilization possibilities of offal or shearings, such as small ears on a pressed piece, should be studied carefully with a view to eliminating them if possible. The former thinking—that the slugs, offal pieces, and shearings are scrap—should be changed to recognize that these pieces are good steel in an unorthodox form.

The return from a carefully planned material utilization program can be quite large. At the Dayton Frigidaire plants the following amounts of steel have been returned

to the productive cycle:

	Per Year
From pressed metal rejects	810,000 lb.
From press offal	4,250,000 lb.
From shearings	1,750,000 lb.
Total	6,810,000 lb.

Reclaiming Metal from Pressing and Shearing

Steel from the rejects of pressed metal parts is usually obtained by trimming or sawing the reject so as to save the largest area of flat stock. For example, rejects from pressed steel cabinet doors are 40 to 57 in. long, depending upon model, and 24 to 33 in. wide and 0.0359 to 0.0418 in. thick. This is usable steel of deep drawing quality, and requires only that the flanges be sawed off to return it to flat stock. It is then suitable for drawing to water heater tops, cabinet center pieces, and other parts requiring deep drawing characteristics. About 22,000 lb. per month were reclaimed by this adaptation.

Cabinet outer shells provide about 19,000 lb. per month of rejects. These are trimmed to remove the flanges top and bottom, and to remove the bends if they have been made. The stock is used for range toe plates.

Offal from the blanking and other presses represents a valuable source of good steel, as it is regular in outline and usually requires no preliminary trimming. Slugs from the burner openings in range cooking tops are 8 13/16 in. in dia., and are enameling iron of 0.0525-in. thickness. These disks were of almost the exact size required for the pulsator diaphragm supports for an automatic washer, pieces formerly blanked and drawn from enameling iron strip stock. The die was redesigned to use the round slugs instead of the strip stock by adding some locating pins. Another model of the cooking range yielded slugs of 6¾-in. dia. Here a die was laid out so as to obtain four cups of 2½-in. dia. in one operation. These are used in the refrigerator as condenser unit mounting retainers.

Shearings do not usually present a problem in their utilization since, with the exception of very short lengths, they can be adapted even to progressive die operations. Our practice is to segregate them by gage and specification and allocate them as soon as production orders are received on parts which call for strip or sheet stock which are adapted to use such material. It is sometimes necessary to shear the stock to the exact width required, but frequently it is only necessary to remove one set of guides, thus permitting the use of variable widths and eliminating the shearing operation.

Salvaging Rejects and Obsolete Parts

An important part of any material utilization program is the salvage of machined parts or subassemblies. The success of salvage of this sort is dependent upon the ingenuity employed in working out repair methods that will not increase costs excessively and at the same time produce a repaired part wholly equal to the standard parts.

When parts are being rejected repeatedly for the same defect, the problem will repay a substantial study and the development of a special repair technique. For example, the scrap on a bearing plate was consistently high due to a flapper valve seat not cleaning up as a result of shrink holes in the castings and some over-size bores on the valve cavity. After study of the piece, it was found possible to make the bore 0.020 in. larger, and to drop the seat 0.050 in., and the permission of the engineering department was obtained for these changes. A larger and deeper salvage valve retainer was then used. This change resulted in salvaging 95% of the bearing plates rejected for these causes.

In a compressor cylinder it was found that a consistent percentage of the units was being rejected because of a dimension from center line to the inside face of the bridge block being outside tolerance. Another model of the compressor pump did not require the vane spring, so that on this model this dimension was no longer critical. The cylinders were therefore converted for use on the model not using the spring, and most of them were again acceptable pieces with only minor work being done upon them.

The welded shell of a compressor sometimes showed leaks when subjected to a pressure test in final inspection. Former practice was to tear down the entire compressor, repair it, and reassemble the unit. Tests showed that it was possible to silver solder some of the shell connectors without disassembling, and without damage to the wiring or other parts of the mechanism. Savings totaled about $26,000 yearly.

Another type of leak in the compressor shell for refrigerators, occurring at a roll-welded seam, was found capable of repair by arc welding with a special low-melting stainless steel rod. Again, the weld repair was made without disassembling, and without damage to the stator coils.

Small standard parts, such as screws, washers, nuts and springs, dropped along the assembly line have a high nuisance value. The total value of the pieces lost may be surprisingly high in the course of a month. These are swept up with other debris, and are ordinarily dumped with the rubbish. For the past two years we have been sorting out these items and returning them to production. The recovery has been profitable even with hand labor, and better methods for cleaning and sorting, now under study, should make the salvage even more attractive.

Obsolete parts are usually small standard parts no longer useful by reason of change of design. Washers, tubing, rod, or small pieces of sheet stock may be obsoleted in this way. Frequently these parts can be adapted for productive use elsewhere than their original application, but when such outlet is not feasible they can sometimes be used for non-productive purposes by the maintenance department.

Corrugated board cartons in which parts or stock are received are always a problem about a plant. Formerly, some were sold but the majority were carted to a rubbish pile and burned, but were troublesome in handling in the trash trucks because of their bulk. As a result of an investigation initiated by Mr. P. A. Metzgar, Supt. of Material Control at Plant #2, it was found that by the use of a slitter and band saw they could be economically cut into pads for the packing of small components when shipping refrigerators. This has not only minimized the problem of handling the corrugated board, but has resulted in the salvage of more than 3,000,000 corrugated board pads and large quantities of indented paper, with net savings in excess of $16,000 per year.

The basic responsibility of the material utilization program is to provide useful applications for the greatest possible proportion of the materials purchased, with the emphasis logically on productive allocation. The ultimate objective is to reoperate or salvage all materials, parts, assemblies or units and return the maximum amount to productive channels or, failing in this, put it to some useful purpose.

by J. G. FORD and A. J. KUTI, Manufacturing Engineers, Transformer Div., Westinghouse Electric Corp.

New Mica Base Paint System Withstands Severe Atmospheric Conditions

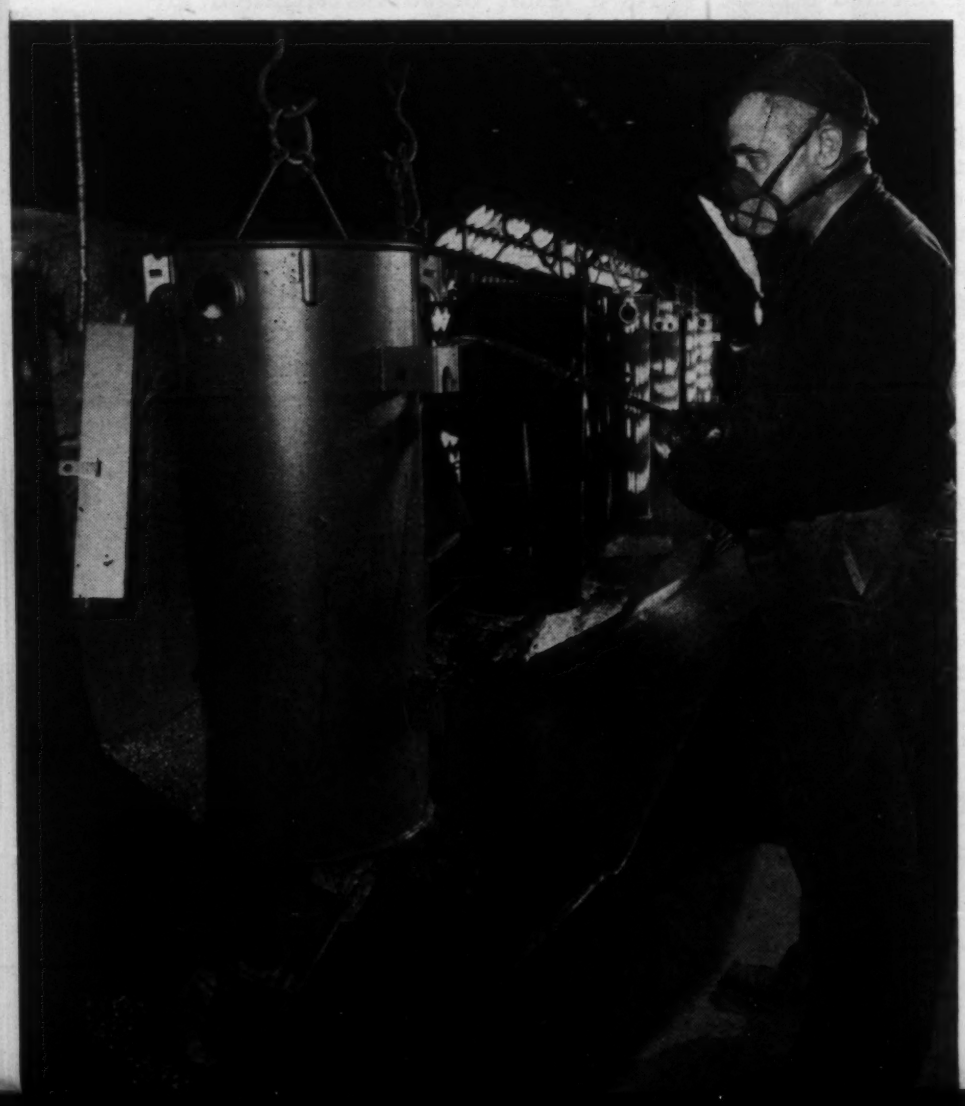
Developed originally for outdoor transformers, this three-coat finish should find use on many other products that are subjected to similar corrosive atmospheres.

• A THREE-COAT mica base paint system that satisfactorily withstands widely diverse atmospheric conditions has been developed at Westinghouse Electric Corp. Named Coastal Finish, it was developed specifically for distribution transformers, but will undoubtedly find use on many other products that require high resistance to varying atmospheres.

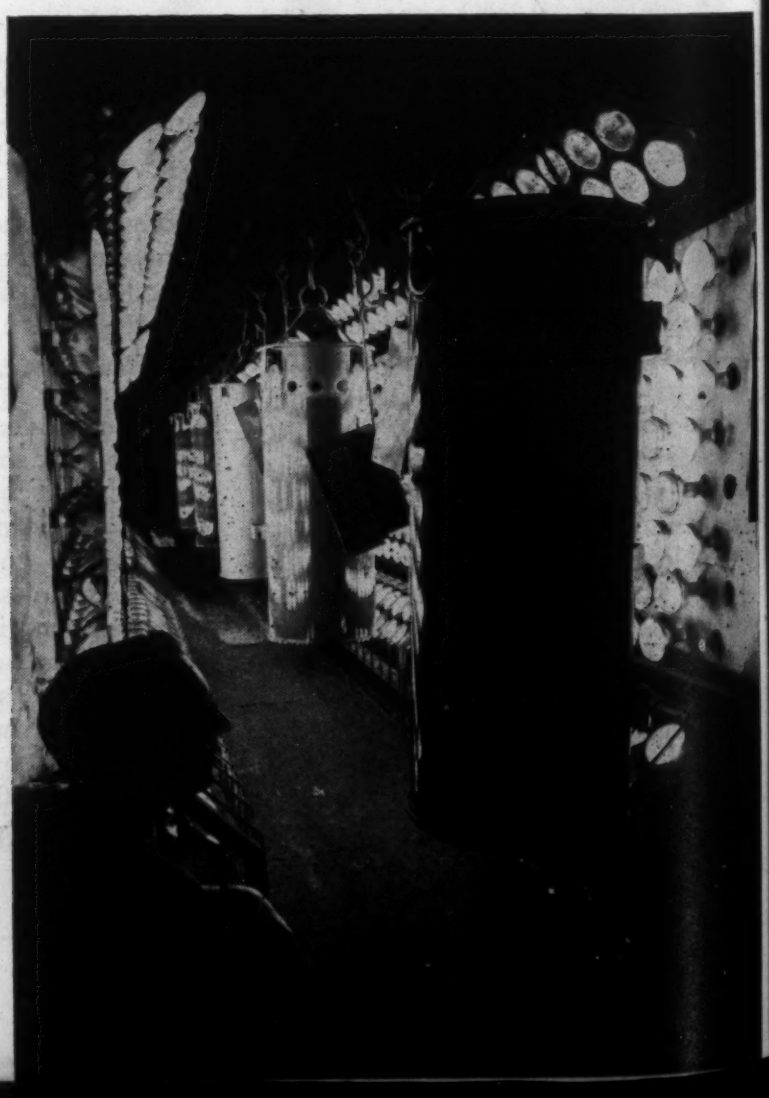
The life of the finish on distribution transformers has been more than doubled by this three-coat paint system. Distribution transformers operate under especially severe conditions that affect the finish applied to the outside of the tank and associated hardware. The surfaces of fully loaded transformers exposed to direct sunlight often reach temperatures of 200 F and sometimes higher. During the winter months these surfaces may be exposed to temperatures as low as —50 F. With an operating range of 250 F the paint must be sufficiently flexible so as not to flake off due to differential expansion and contraction between paint and metal. Elevated temperatures and oxygen of the atmosphere also cause the paint films to age and become brittle. This accelerates the tendency to flake or craze during the winter months.

Moisture in liquid or vapor form is, perhaps, the greatest enemy to the finish on distribution transformers in ratings commonly hung on poles. It readily attacks any exposed steel surface forming rust, and gradually penetrates paint films corroding the metal underneath. Once the film is broken, corrosion is accelerated and pits develop. If they are not given attention they may eventually completely penetrate the tank wall and cause the transformer to fail. Oxygen,

The primer, or first coat, is applied by flow coating using standard equipment, after which it is dried in an infrared oven.



Transformer tanks emerging from the oven are now ready for the second coat.



salts, acids and alkalis present in the seacoast and industrial atmospheres usually are destructive as they deteriorate the film and pave the way for moisture to do its damage. Also, the effects of certain impurities accelerate corrosion by moisture once it gets to the metal.

The Three-Coat System

The individual coats of the new three-coat system act cooperatively to resist moisture penetration and also the elements that promote it. The prime or first coat is composed of a vehicle giving good adhesion with desired flexibility and chemical resistance to salts, acids and alkalis. The pigments used are primarily zinc chromate and iron oxide. Zinc chromate is perhaps one of the best corrosion inhibiting pigments due to the availability of the chromate ion in the presence of moisture. However, if used as a single pigment, it usually produces a film that is somewhat brittle. When combined with iron oxide, the brittleness of the film is reduced and the vat or storage life of the paint is increased. Surprising as it may seem when this combination is tested as a priming coat alone in comparison with other primers containing, for example, lead chromate or red lead, it may at times appear to be inferior. The superiority stands out when the tests are repeated after the finish coats have been applied.

The second or intermediate coat is without doubt the key to the successful performance of Coastal Finish. The vehicle is composed of modified phenolic and alkyd resins. These are chosen for resistance to heat, oxygen, salts, acids and alkalis in concentrations generally encountered in the atmosphere. The resin is of the thermosetting type. By proper selection of solvent and adjustment of setting time of the resin, it is possible to remove the solvent completely during the initial part of the drying cycle before the resin has set to the hard state. This permits the resin to flow after solvent elimination and prevents pinholes through which oxygen and moisture could enter.

The pigment is composed of selected mica flakes which overlap each other in the film and produce a "shingle roof" effect to further ward off moisture and oxygen. The mica also increases heat stability of the intermediate coat as much as ten times at elevated temperatures. It appears also that the mica improves coverage on sharp or honed edges, thus reducing tendency to corrode at these points.

The use of mica in paint is not new but the way in which it is used in this paint has not been utilized in the past. The relatively large mica flakes, plus their tendency to settle, presented problems of application but these have been overcome.

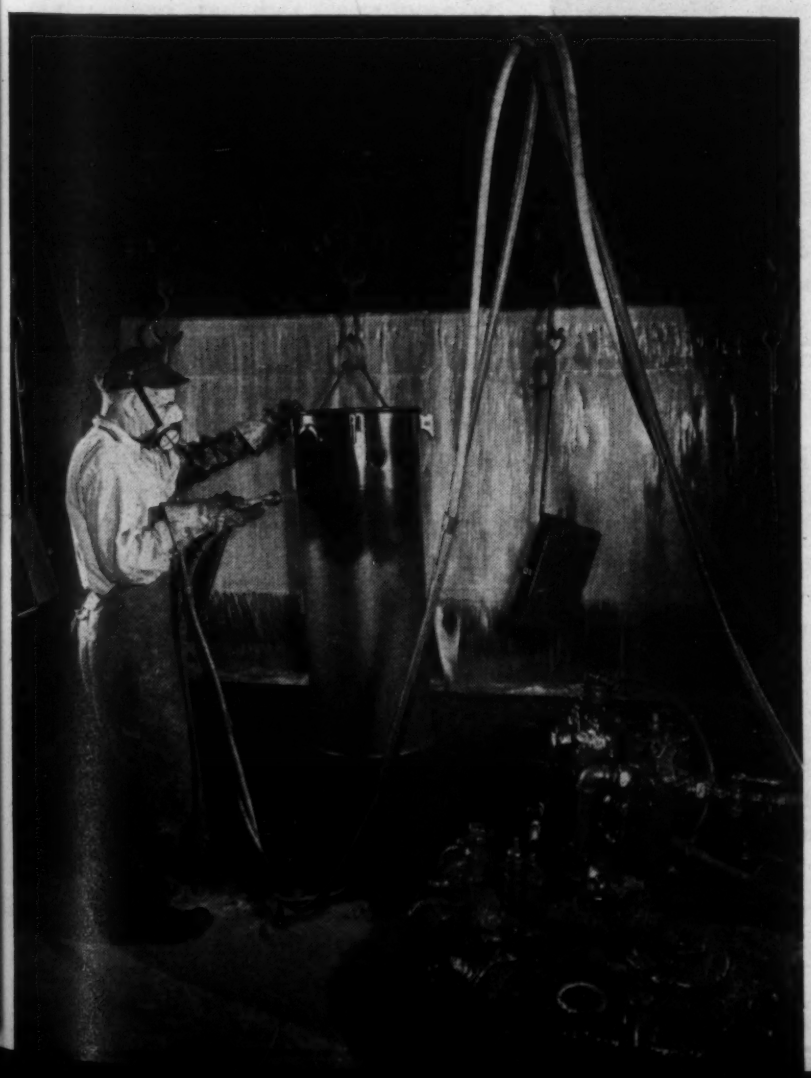
The third and final coat is composed of resins and pigments to withstand the elements and to provide good appearance when new and after weathering has taken place. It can be tinted to give any desired color. When chalking takes place, a slightly darker shade develops which does not detract from the appearance of the transformer.

The final coat has several functions: (1) It adds to appearance; (2) it enhances the resistance of the other two coats to oxygen, moisture, etc.; and (3) it screens out the ultraviolet light of the sun's rays.

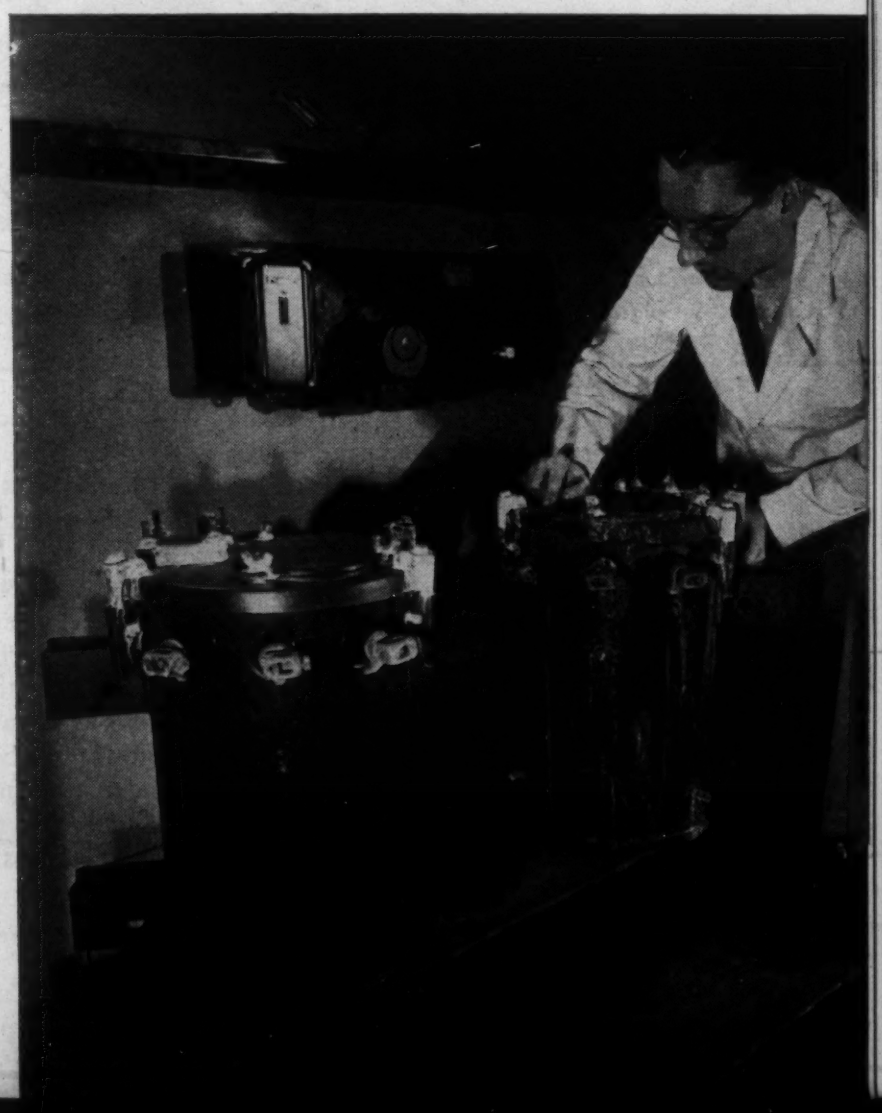
A series of panels was made to demonstrate the resistance of the combination of primer and mica-filled second coat to salt spray and weathering. These panels were phosphatized, given a coat of primer and then two coats of the intermediate, or second coat, of the system. They were tested simultaneously with panels painted with the standard three-coat finish.

After 2000-hr. exposure to the salt spray the mica finish showed no change, whereas the standard finish was approximately 50% deteriorated. At 3000-hr. the standard finish was completely gone. It required a total of 10,000-hr. continuous exposure to

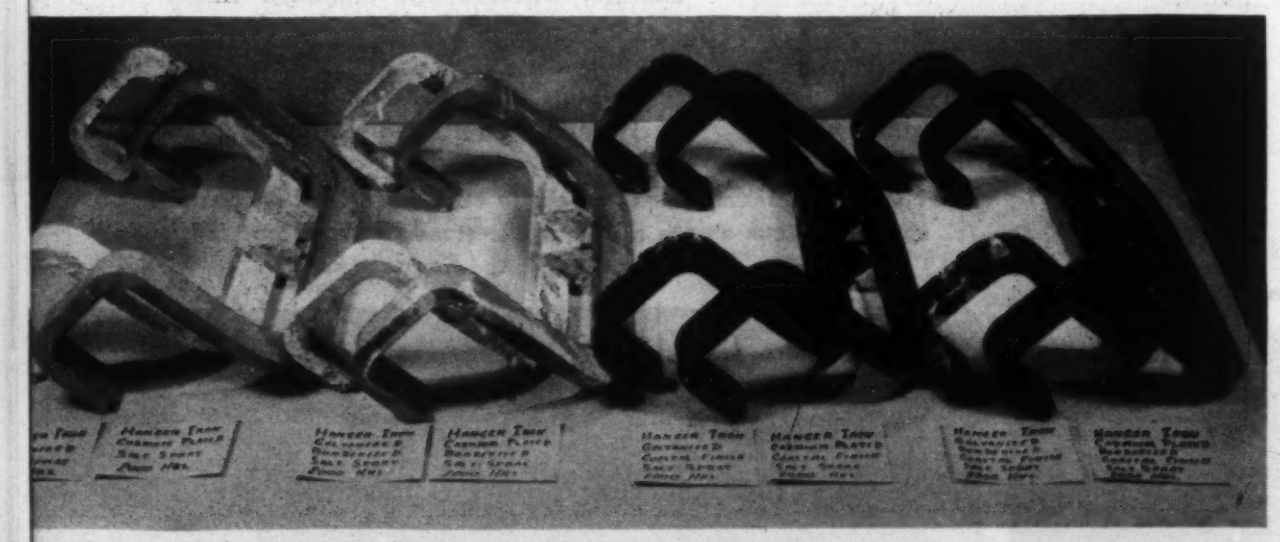
The second, or mica base coat is applied by spraying.



The two transformer tanks were both exposed to 1000 hr. of salt spray. The tank on the right had the standard three-coat finish while the one on the left had Coastal Finish.



After 2000 hr. of exposure to salt spray, a large area of the standard finish on the panel to the left was gone and corrosion was apparent, while the mica base finish on the panel to the right showed no corrosion.



Various finishes on hanger irons were exposed to 2000 hr. of salt spray. Only the cadmium-plated and Bonderized plus mica base finish hangers showed no signs of attack.

salt spray before small blisters began to appear on the mica finish. When the blisters were broken, there was evidence of trapped gas, possibly hydrogen, and a thin film of rust.

Other mica-finished panels were exposed for 18 months on Florida and California seacoasts. Weathering took place at the surface exposing some of the mica flakes. However, there was no sign of corrosion.

Methods of Application

The metal surface is first alkali cleaned and rinsed to remove all rust, scale, dirt and grease. This is followed by phosphatizing and a dip in dilute chromic acid. This results in a very clean surface light gray in color and of sufficient porosity for good paint penetration with maximum adhesion. To prevent any contamination of the prepared surface, the first or priming coat is applied within a matter of hours by flow coating. The three-coat system can be applied and baked by any of the conventional methods. The flow-coating process is used for priming the transformer tanks to fill any crevices left between tank wall and projection welded parts. It also assures complete and uniform coverage of all parts. The primer coat is then baked in an infrared dryer. A surface temperature of approximately 340 F is reached by the time the tank leaves the oven.

After cooling, the second coat is sprayed on. A dark green dye is incorporated into the otherwise clear mica base paint or enamel to assist the operator in determining coverage and to allow for easy and quick inspection. The dye fades out, leaving a dark-brown color on subsequent infrared baking, which is done in the same type oven and at the same temperatures as for the first coat. The film dries to make a hard, tough, abrasion resisting coating.

Not until the transformer is completely assembled and tested is the third and final dark-gray coat applied. The transformer is then conveyed through a steam convection oven operating at 160 F where the final coat is dried tack-free. Hardening of the film takes place in storage and shipment.

Salt Spray Resistance

This test is made in standard salt spray equipment using a 20% solution of sodium chloride at 90 F with 15-lb. pressure on the spray head. The effect of 1,000-hr. exposure to this salt spray test on two transformer tanks is shown in an accompanying photograph. The standard finish on the transformer tank showed considerable deterioration and severe corrosion, although the photograph does not bring out the real severity of corrosion and attack on the finish. As an example, the finish was completely gone from the cover and from many areas on the tank wall. By comparison, the Coastal Finish on the transformer showed no signs of deterioration and no signs of corrosion.

Further confirmation of the improved salt spray resistance of mica base finish over the standard finish was obtained from test panels after submitted to 2000 hr. of salt spray. A large area of the paint was gone on the panel coated with the standard finish and corrosion was quite apparent, whereas with the mica base finish there is no indication of corrosion.

One rather interesting result was the severe action of the salt spray on galvanized parts. This was indicated by the white deposits on the hardware. As a result it was considered

desirable to test the mica base finish on hanger irons for distribution transformers where standards now call for galvanizing.

The test samples included were as follows: galvanized; cadmium plated; galvanized and Bonderized; cadmium plated and Bonderized; galvanized plus mica base finish; cadmium plated plus mica base finish; galvanized and Bonderized plus mica base finish; and cadmium plated and Bonderized plus mica base finish. After 2,000-hr. exposure to the salt spray it was found that the zinc had been completely consumed on the galvanized hanger irons with iron rust spots showing through the white deposits of zinc salts. The cadmium plated irons showed fairly good resistance to salt spray but small areas were attacked. The iron was not corroded. The galvanized and Bonderized and the cadmium plated and Bonderized iron showed up extremely well. The galvanized and painted and cadmium plated and painted irons showed extremely good resistance to salt spray with practically no indications of attack. Of all the combinations tested, the cadmium plated and Bonderized plus mica base finish irons showed absolutely no signs of attack after 2000 hr.

For these tests, ordinary production hanger irons were used. It is realized that the salt spray is a grossly accelerated test and that galvanized or cadmium plated parts stand up well in marine and most industrial atmospheres. However, it is felt that the Bonderizing plus mica base finish greatly enhances the protection already given by the electropositive metal.

Acid and Alkali Resistance

In this test the test panels were periodically exposed to an acid bath and then to air. An 0.5% solution of hydrochloric and sulfuric acid was used.

The standard finish had excellent acid resistance and there was little difference between the standard finish and the mica base finish after 500-cycle exposure, or a total of 1,000 hr. in acid and 1,000 hr. in air. Deterioration first took place at the extreme bottom edge of the panel due largely to the increased concentration of acid at this area. When the panels are removed from the bath for air exposure, drainage takes place. Evaporation of water during the drainage period results in increased concentration of acid at bottom of panel.

The alkali test is performed in a duplicate set of equipment. For this test an 0.5% solution of sodium hydroxide is used. There is quite a distinct difference between the effect of alkali on the standard finish and the mica base finish. In the case of the standard finish, the three coats were completely removed exposing bare metal which at the end of 500 cycles had begun to show a rust stain. In the case of the mica base finish under the same exposure some deterioration of the final coat was shown; however, all three coats were intact and no signs of corrosion of the base metal were observed.

Weathering Resistance

It is generally considered that one week's exposure to Weather-O-Meter conditions is about equivalent to outdoor exposure for a period of one year under average conditions. In the Weather-O-Meter test, the panels are attached to a cylinder and rotated continuously. They are exposed to periodic cycles of 1 hr. in fog and 3 hr. under ultraviolet light. Neither finish showed severe deterioration. It was noted that the final coats on both the standard and mica base finish showed some dulling and evidence of light chalking. Tests are being continued to obtain the ultimate life of the two finishes under this condition.

Panels of the standard three-coat finish and the three-coat mica base finish were prepared and exposed on both Florida and California coasts. At the end of 18 months none of the mica base panels had shown signs of corrosion. The standard panels showed edge corrosion and rust creepage to the extent of about 1/16 in. in from the edge. Some chalking had taken place on both panels. This was particularly true for the panels exposed on the Florida coast. It is interesting to note that the panels exposed on the California coast at San Francisco still have most of the original gloss.

Panels with mica base finish and panels with standard finish were exposed in this Weather-O-Meter. After 12 weeks of alternating cycles of 1 hr. in fog and 3 hr. under ultraviolet light, both samples showed some chalking but no severe deterioration.

Hot Oil Quenching Reduces Distortion in Hardening of Steel Parts

by KENNETH ROSE, Western Editor, Materials & Methods

This new isothermal heat treating procedure, called Marquenching, produces more uniform hardness, reduces residual stresses, and almost entirely eliminates warpage.

• WHEN A SERIES OF brilliant researches established the relationship between properties of steel and microstructure, the study of rates of transformation of the constituents became of great practical importance. About 20 years of study brought about the plotting of transformation rates as the S-curve and other transformation curves, and the application of this knowledge to the practical heat treatment of steel in a number of isothermal processes.

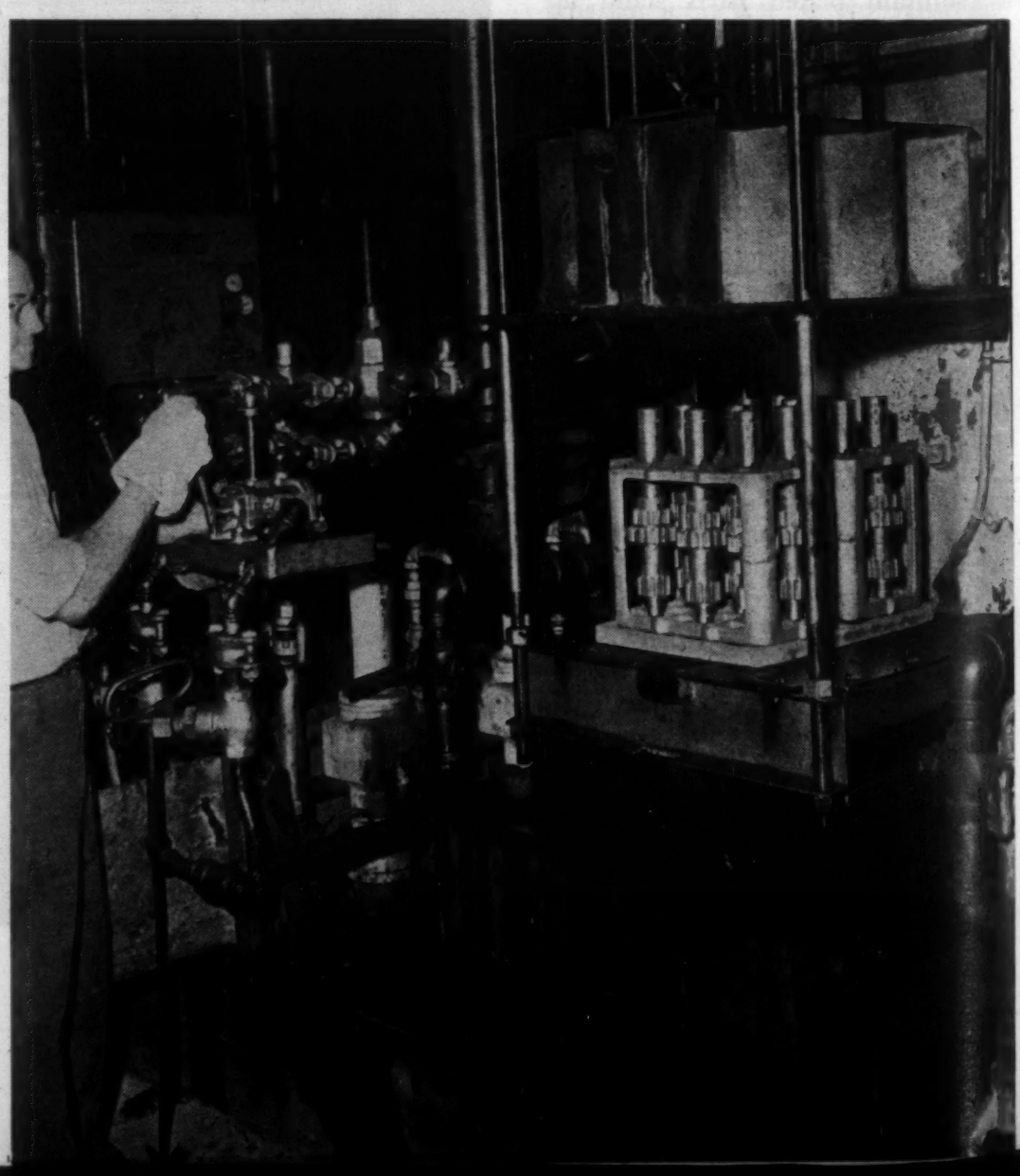
Briefly, isothermal processes involve holding steel at some temperature, or within a narrow temperature range, until a desired transformation has been completed. It has been found that the structure can be much more closely controlled in this way to produce work with more uniform hardness, or to reduce warpage due to the volume changes associated with the transformations.

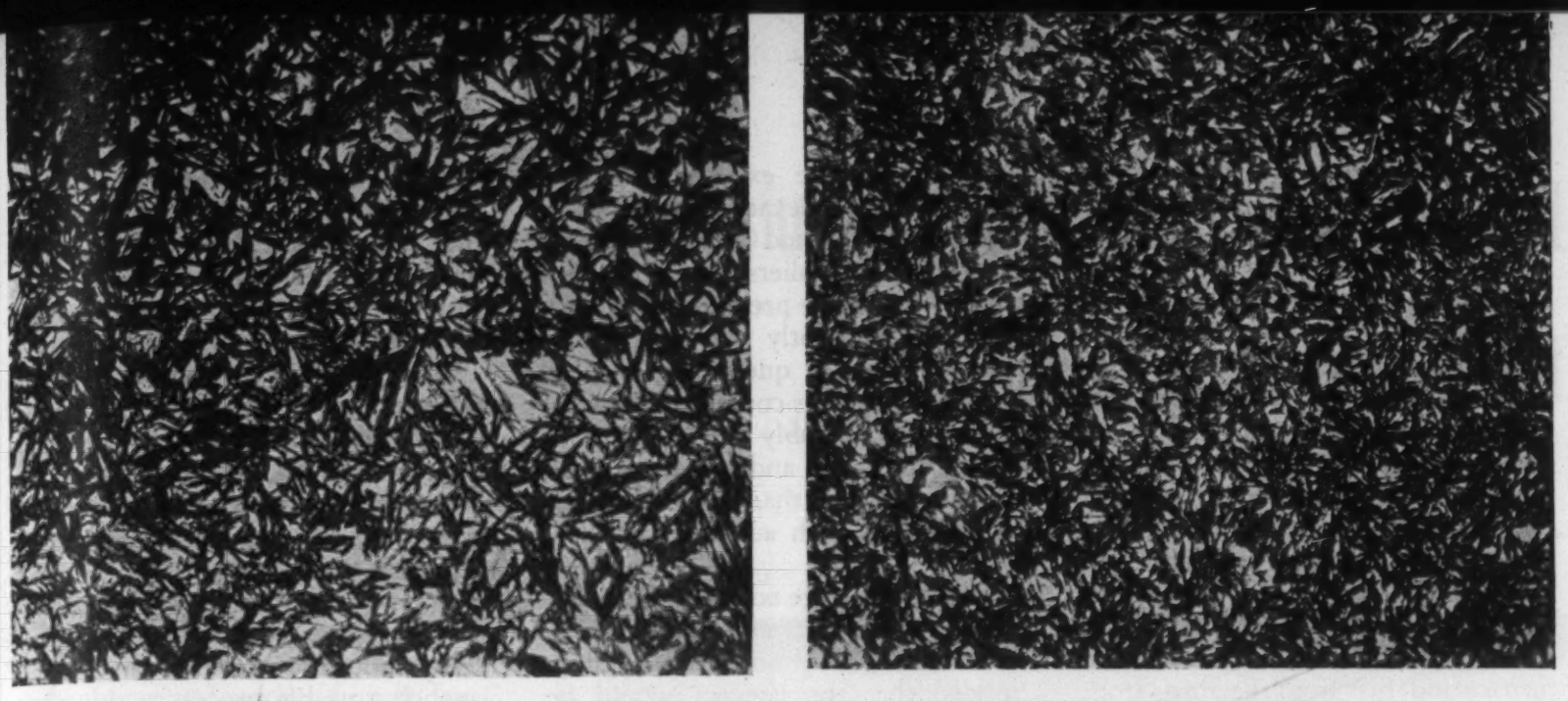
Such isothermal processes have been developed for hardening, tempering and annealing. The most recent of these isothermal processes to attract attention is the quenching of steel in a medium held at a temperature near the upper limit of the range for the martensite transformation, so that the quenched piece will have a structure consisting of practically pure martensite. Subsequent tempering will produce a tempered martensite structure. As these changes are accompanied by the principal volume change in the steel transformations, control of warpage and of residual stresses is also important.

Hardening Procedure

In general, the desired procedure is as follows: The steel is heated to a temperature for a length of time that will insure converting all constituents to austenite. The austenitizing temperature varies with the composition of the steel, but will usually lie between about 1550 and 1700 F. In order to obtain a quenched structure that will be as nearly as possible 100% martensite, the steel is cooled as quickly as possible to a temperature at which the transformation of austenite into martensite begins. This is usually about 500 F. Slow cooling through the range between these temperatures will produce a mixed structure in the steel, with decreased hardness in the quenched material. After the steel has reached the temperature at which the transformation of austenite to martensite begins, the trans-

Transmission countershafts on the lowerator ready to be quenched in Marquench bath.





Photomicrographs of conventional quenched case (left), and Marquenched case (right). (X500)

formation occurs progressively as the temperature of the steel is lowered, until it is complete.

The time within which the steel must be cooled from the austenitizing temperature to the temperature at which the martensite transformation begins can be obtained from the isothermal transformation diagram for that particular type of steel. The time is a matter of a few seconds for most steels. Failure to cool the steel to about 600 F at a sufficiently high rate results in the transformation of a part of the austenite into pearlite or bainite, with lowered hardness in the quenched piece.

In putting this procedure into operation, the steel is quenched into hot oil, with or without agitation, and held in the oil bath until the temperature of the steel falls to that of the oil. The work is then removed and the cooling continues in air. Theoretically, the quenching oil should be held at about 500 F, arresting the cooling at a temperature at which the martensite transformation would have just begun, for most steels. In practice this temperature is so high that the oil deteriorates rapidly; also, danger of fire is considerably increased. Therefore, temperatures used range from about 500 F to about 200 F. Quenches near the upper limit of this range are approaching a true isothermal quench, while those at 200 F do little more than reduce the thermal shock of quenching, and thus help to minimize warpage and cracking of the pieces during the cooling process.

Uses of the Process

Recent interest in hot oil quenching was developed by announcements from International Harvester Co.'s Fort Wayne Works of their results with a true isothermal quench. The process was worked out for gears and other close tolerance pieces that had been handled in special quenching fixtures, and afterwards was applied in rearranged heat treating equipment that eliminated the pressure quenching and fixtures while holding dimensions within tolerances. International Harvester Co. refers to its process as marquenching, to indicate that it is a quench interrupted at the point of transformation of austenite to martensite, so that the martensite transformation is completed in air.

Hot oil quenching is used in connection with gas carburizing to harden the case. The company uses the following types of steel for gears, king pins and shafts now being isothermally quenched: 8620-H, 4820-H, 4815-H and 4620-H. The oil is held at 400 F. Lowerators at the discharge end of the carburizing furnace take the work from the furnace to the quench tank. The work is exposed to room temperature for only about 20 sec. In the 1600-gal. quench tank the oil temperature is held closely to the 400 F temperature fixed upon, with thermocouple controls located directly under the point where the work is quenched. Radiant tubes in the oil provide for heating or cooling as required. Time of immersion is automatically controlled, and at the end of the quench period the work is raised from the tank and transferred to baskets to permit complete transformation to martensite, which may require as long as 5 hr. for some parts.

Heat treatment is completed by washing the work, and tempering at 300 F for 1½ hr. to produce a tempered martensite structure in the case. In addition to only very slight distortion, thus keeping the work within dimensional tolerances, International Harvester Co. reports that the process reduces residual stresses to such an extent that service life of gears is increased 100 to 200% and load-carrying capacity increases from 15 to 20%.

Other large manufacturers, especially those in the automotive industry, have studied hot oil quenching also. Reactions have been mixed. Some of the objections given are:

1. The oil tends to deteriorate rapidly at the temperatures that give best results with the steel.

2. For parts requiring extreme accuracy, as automotive gears, a finishing operation after heat treatment is necessary to hold tolerances.

3. The various steels do not respond equally well to the quench.

Difficulties with the oil have been a serious drawback to use of the process, with several of the leading manufacturers trying the process. One reported that with the oil at a temperature near 500 F, his laboratory results were excellent metallurgically, but that the oil deteriorated so rapidly as to make the process unworkable under shop conditions. Another automobile manufacturer, using a 400 F bath, reported that the oil became noticeably thicker within a few weeks, and that two months of use caused it to thicken to the consistency of a thin tar.

Most users reported encountering trouble with the oil at temperatures in the 400 F range. A supplier of precision parts to the automotive industry, with a highly-regarded metallurgical department, has fixed upon 250 F as the best temperature for quenching oil. This temperature gives long oil life and is near the usual lower limit for the martensite transformation.

A supplier of quenching oils gives these reasons for oil deterioration during hot quenching:

1. *Oxidation.* The oil is subjected to accelerated oxidation at these ele-

vated temperatures. Anti-oxidants, frequently phosphates, are available as trade-named products to be added to the oil, and these may retard oxidation, but cannot eliminate it.

2. *Vaporization.* The lighter fractions in the oil are boiled away at the temperature of use, and the heavier fractions accumulate, causing an increase in viscosity. Addition of a wetting agent will help to mitigate the effects of the increase in viscosity. Adding lighter oil to the bath will lower the viscosity, but large additions are not usually justified.

3. *Contaminants.* Soot from the furnace and dust from the air or from the work help to form sludge in the quench oil. Keeping the oil bath covered, and avoiding sooting, will help to control sludge formation from this source.

Oil cannot be expected to give good service at elevated temperatures for as long a period as at room temperature, oil suppliers warn, and steel treaters should be prepared to replace oil more frequently when service is severe. When a quenching oil becomes thick and is contaminated with sludge, it is probably best economy to discard the batch and replace it with fresh oil, rather than to attempt to rejuvenate it with additives or diluents.

One of the large automobile manufacturers, after a careful research program dealing with hot oil quenching, decided that the process would be usable in the plant only after considerable revision of the operations for producing gears. Gears are held to tolerances of about 0.0002 to 0.0005 in., and are finish broached after hardening to clean up the size. It was found that hot oil quenching did not reduce distortion over the amount developed with the quench system then in use, which involved quenching in oil warmed to about 130 to 140 F. The number of pieces falling outside the dimensional tolerances following the finish broaching after hardening was large enough to make necessary a revision of the operations before the interrupted quenching system could be adopted. It was decided, therefore, that only a considerable revision of the plant setup could make the interrupted quench a usable process at this plant.

An important consideration in hot oil quenching is the type of steel being used. With plain carbon steels the martensite transformation occurs almost instantly as the temperature of the steel falls from the point at which the transformation starts. The transformation is complete when the steel has cooled. With the alloy steels, however, the transformation takes place more slowly. Nickel and manganese are austenite-formers, and slow the transformation noticeably. Steels with about 3.5 to 4.0% nickel may require several days to complete the transformation in air. In the chromium steels the transformation will be speeded slightly.

An important supplier of heat treating equipment reports that the transformation rate of the slow-transforming steels can be speeded by holding the quench oil at a temperature slightly below 400 F—perhaps at 350 F—so that the change to martensite will be started before the cooling is interrupted. With about 10 to 20% of martensite already formed, the remainder of the austenite is more rapidly converted to martensite after the work is withdrawn from the quench. Interrupting the quench at a point above the temperature at which the martensite transformation begins will have the opposite effect of slowing the change to martensite.

The quenching of steel in hot oil holds out possibilities for slowing down the rate of transformation to martensite, and so to reduce distortion of pieces finished to size. The experience of many companies with this interrupted quench shows, however, that the process must be carefully studied in the light of each individual case. The amount of distortion permissible, the processing of the pieces before heat treating, the composition of the steel, the temperature of the oil, and the rate of breakdown of the oil must all be considered.

Chart showing how distortion of transmission drive gears was reduced by adopting hot oil quenching method.

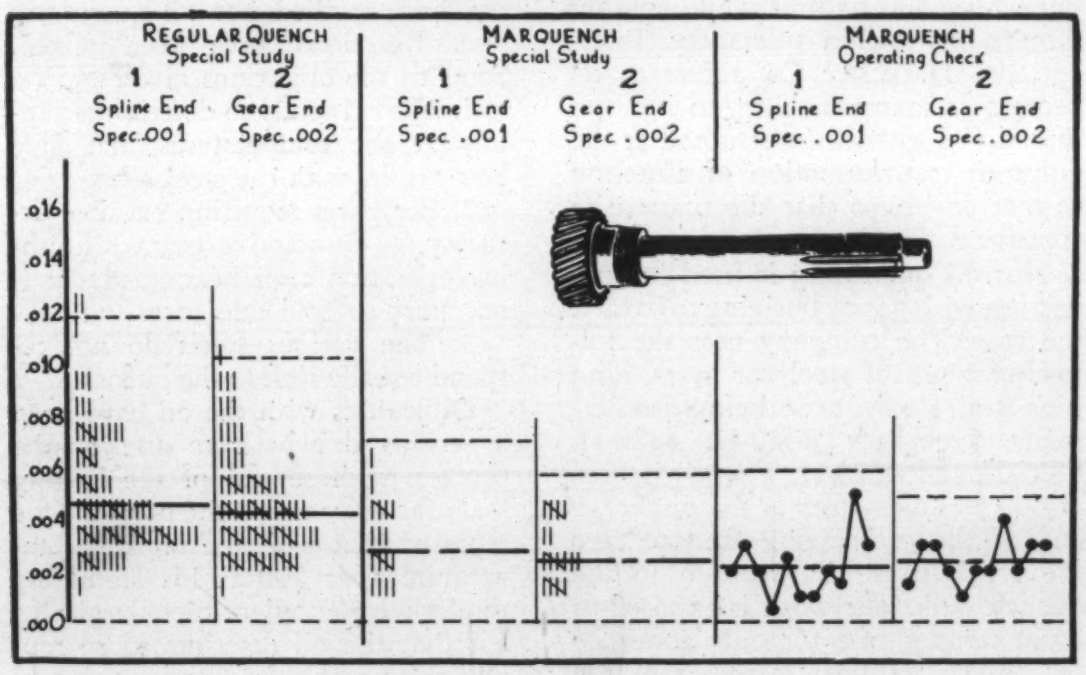
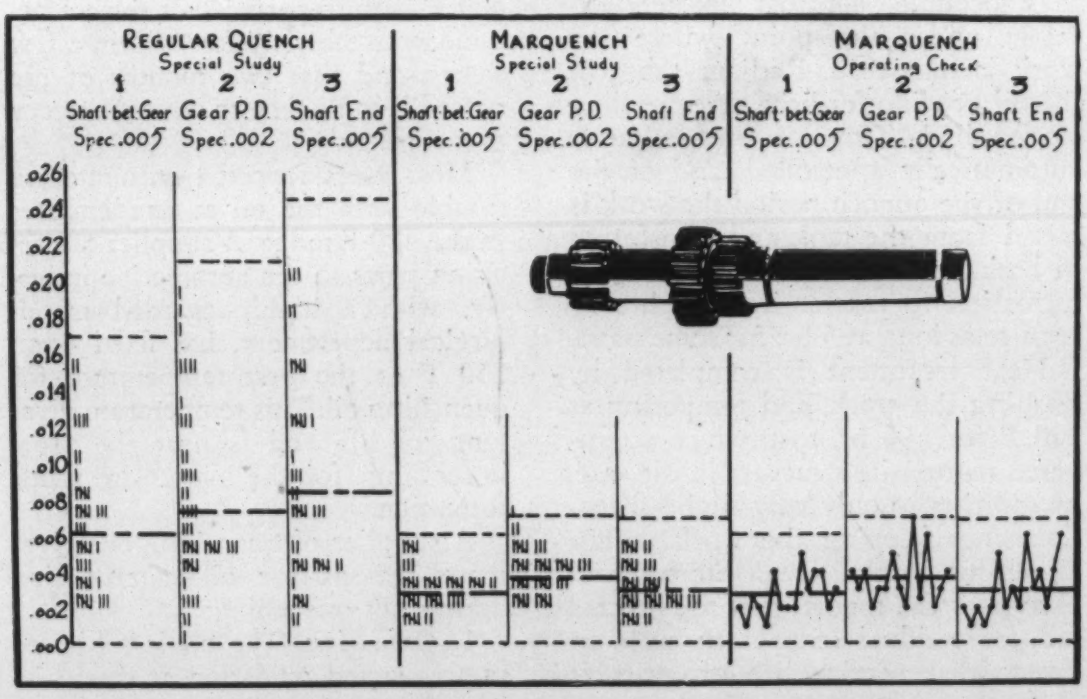


Chart showing run-out of main transmission countershafts when hardened by conventional methods and by Marquenched method.



Magnesium Tubing Spun and Brazed to Produce Critical Part

by DON C. LAW, General Manager, Magline Inc.

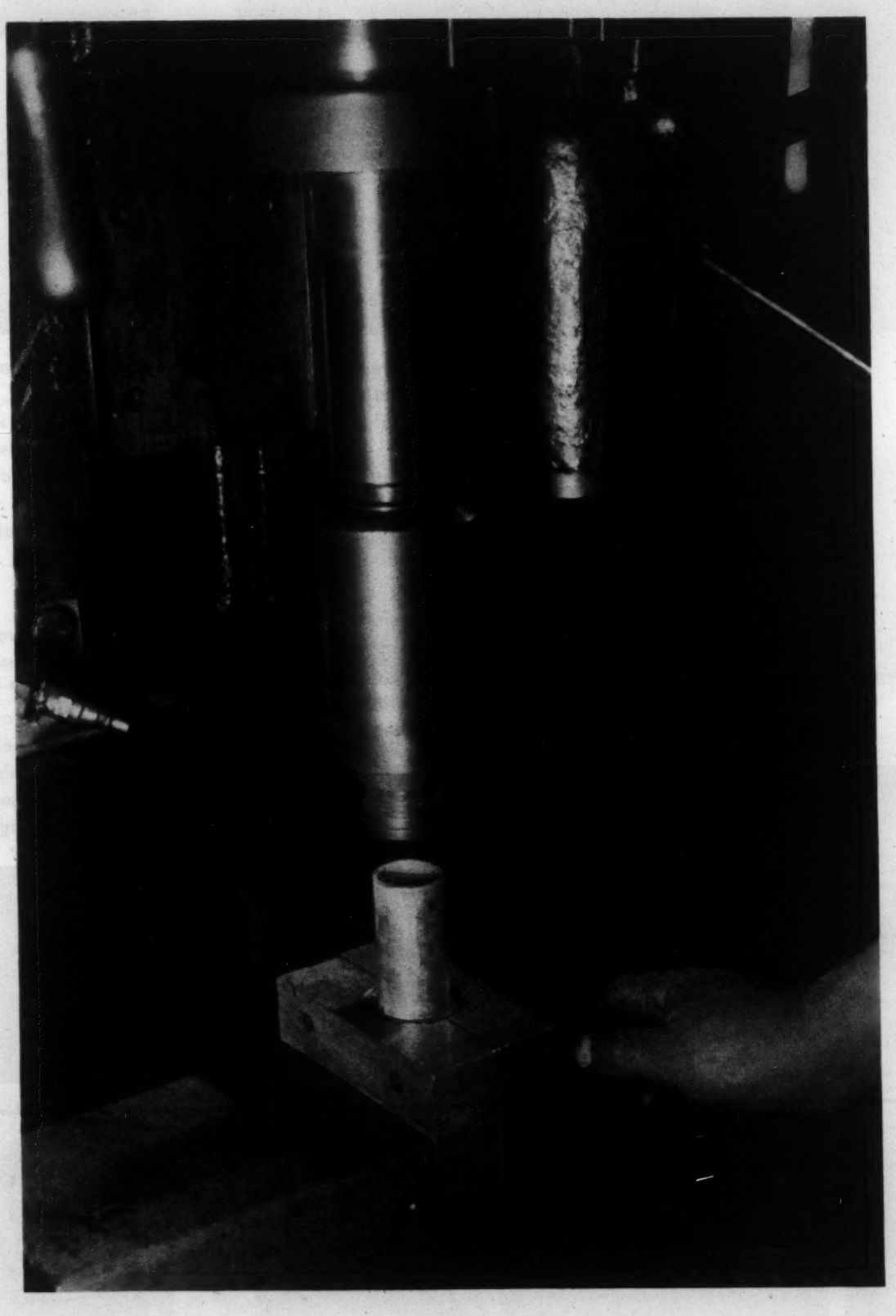
• A SPUN AND BRAZED magnesium part has provided the solution to a problem which has troubled manufacturers of hydraulic automobile lifts for years—the corrosion and occasional failure of a small, but important float.

In normal operation of the lift, when the oil in which the float is partly immersed reaches a given level, the lower end of the float rests on a 45-deg. seat and prevents air from passing into the hydraulic cylinder. If the float fails or leaks, however, and allows air to enter the cylinder, there is a possibility that the lift will fall, endangering life and property. At best, the lift will chatter and operate irregularly.

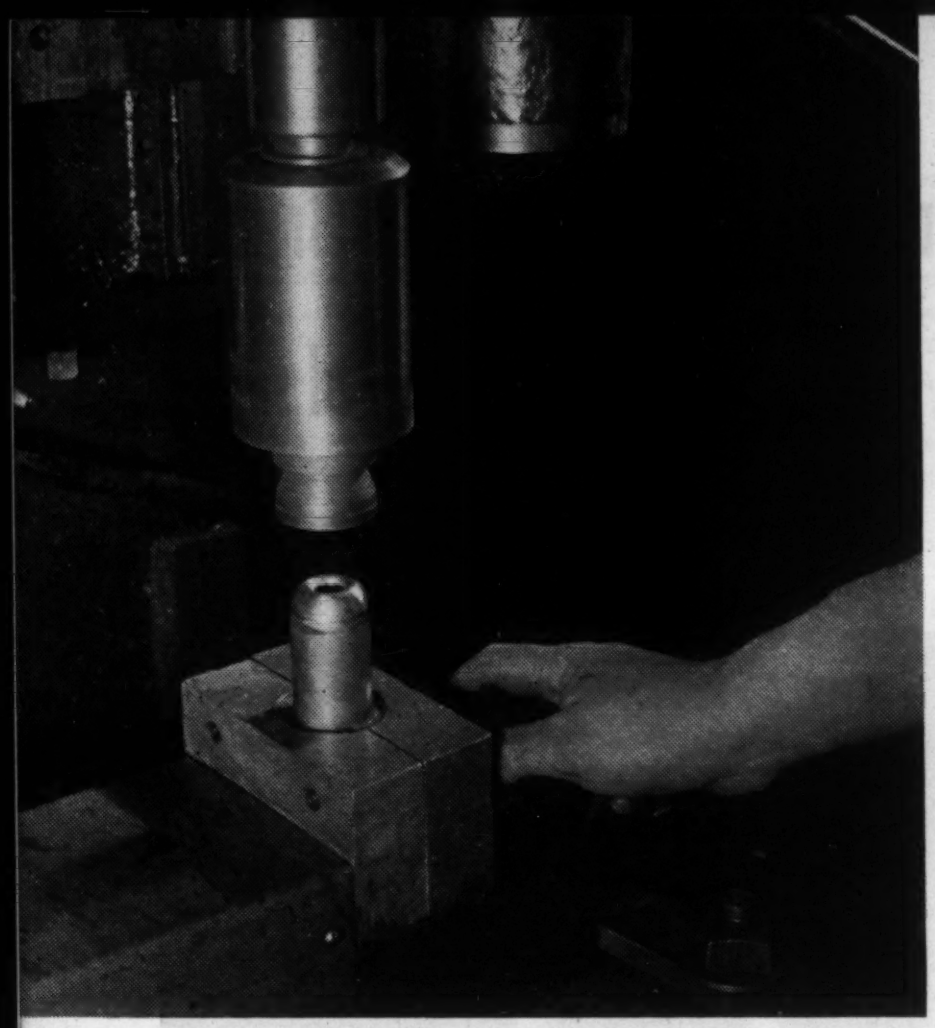
For many years, the Joyce-Cridland Co., Dayton, Ohio, producers of hydraulic lifts, had sought a light-weight float that would function indefinitely without corrosion, although it was to be used in pits where corrosive conditions often prevail and where servicing is extremely difficult. Many metals were tried, including several copper alloys high in corrosion resistance. But the high specific gravity of the alloys necessitated use of thin-walled stock to give the desired buoyancy in the space available, and occasional failures occurred.

It was finally decided to try a magnesium alloy, with which a 1/16-in. side wall and a thicker bottom (for a seat) could be permitted, provided that production of the magnesium floats was commercially feasible. Magline, Inc., Pinconning, Mich., undertook the job and, using both spinning and brazing operations considered unusual in the working of magnesium, is now successfully mass-producing the floats. In a subsequent operation at another plant, the float is plated—another uncommon procedure in the manufacturing of magnesium products. Substantial coats of zinc, copper and cadmium are applied, and the final coat is given an Iridite treatment. The final result is considered highly satisfactory, and "Magna-Guard" lifts incorporating the new float are now being marketed.

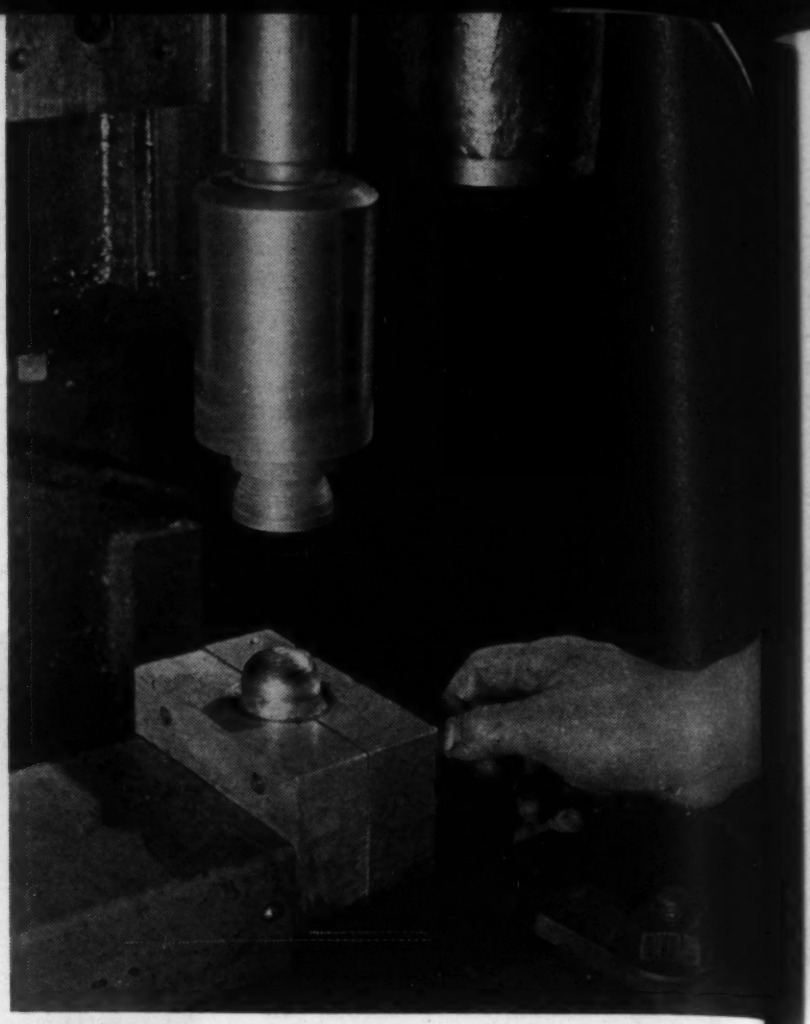
The accompanying pictures illustrate the production of the float from its beginning as a 5-in. length of extruded Dowmetal M alloy tubing to the completed product, polished and plated.



1 *Air-clamped in a simple holding fixture on the bed of a drill press, the 1⅜-o.d. magnesium alloy tubing is ready for the first forming operation. Poised above the tube is a KM tool steel spinning tool, which has an annular recess of slightly more than 1⅜-in. dia. At the center of the recess is a tit connected by a radius to a larger diameter while, outside, the tool is cut away to provide a cup of nearly uniform thickness.*



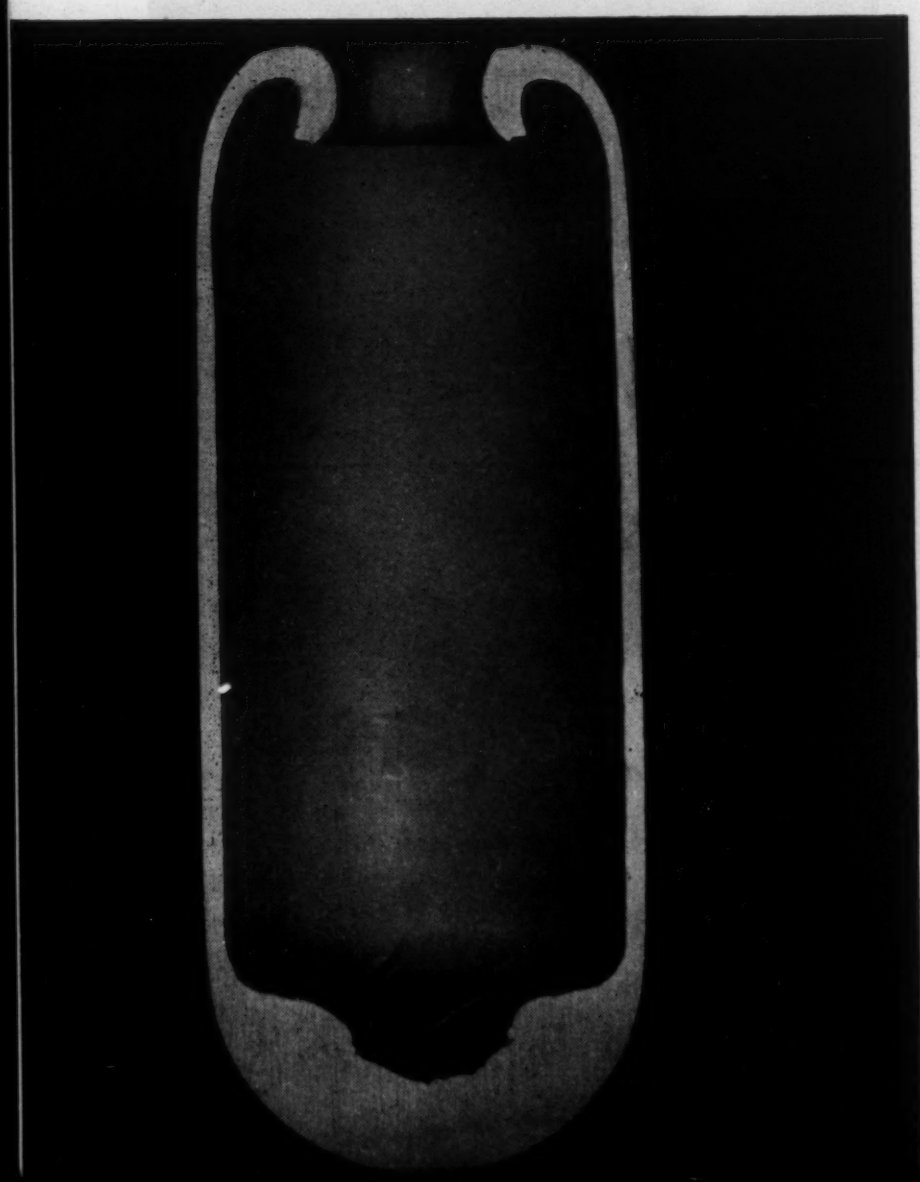
2 *When the tool, driven at 1250 rpm. and fed down at the rate of 10 in. per min., contacts the work, the temperature of both the tool and the magnesium rises—a condition favorable to spinning because of the increased ductility of the magnesium. The combination of heat and pressure produce a reentrant flange in the tube wall, while the wall itself is somewhat thickened at the hole formed by the tit.*

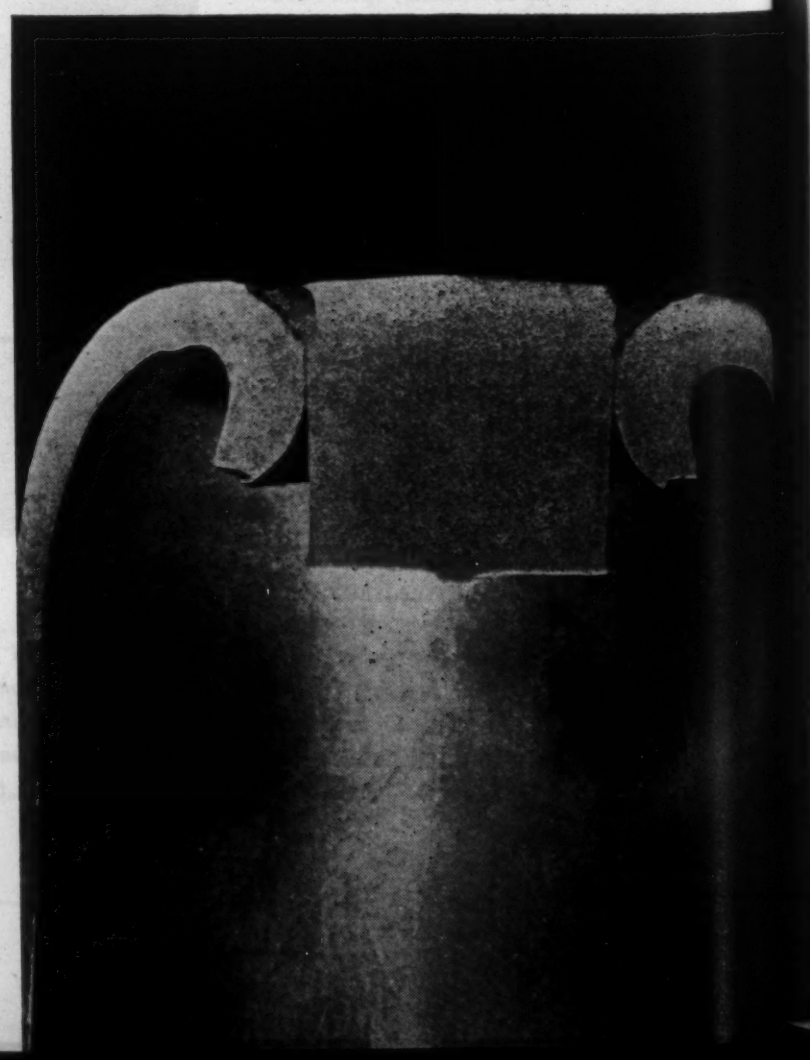


3 *Another spinning operation, employing the same set-up but a different tool, is used to form the other end of the tube. When this tool, with a hemispherical recess of about 1⅜-in. dia. but no tit, is power fed, the wall is not only spun inward but is greatly thickened. Since the temperature rises close to the melting point of the magnesium alloy (1220 F) during spinning, complete fusion results and no trace of a hole is left. If the tool becomes too hot during a long run, it is cooled with an air jet from the nozzle at the left.*

4 *This cross-section view shows the float after the completion of the spinning operations. Despite the fact that the end of the tube is thickened considerably when it is spun closed, it is not thick enough to contain a tapped hole called for in the specifications. For this reason, space is left at one end of the tube to fit a tapered plug, in which the hole is subsequently drilled and tapped.*

5 *Plugs are produced on a screw machine from rod stock of the same alloy used in the tubing. Tapered to make a tight fit, they are pressed into the open end of the tube until flush with the top. This leaves a V-shaped annulus around the plug to be filled in with metal during the brazing operation. For brazing, a rod of magnesium alloy with a lower melting point than that of the plug is used so that there is no chance of the plug melting and falling through the hole.*





6 *In brazing, the hottest reducing oxy-acetylene flame is directed against the plug (which has the thickest section), and heat is conducted to the walls of the hole in the tube. The rod is heated in the flame and drips into the annular groove until it is filled flush. Actual brazing temperature (1130 to 1160 F) is rapidly attained because of the low specific heat of magnesium. A chloride flux is used.*

7 *Upon cooling, the floats are dipped in a chromic acid pickle to remove the flux, and then rinsed in water. After a polishing operation, the floats are dipped in a zincate solution to provide a thin layer of zinc as a base to which subsequent coats are applied. This is followed by plating operations, which deposit layers of copper and cadmium, after which a clear Iridite "sealer" is applied to inhibit the corrosion of the cadmium. The completed float and a longitudinal section are shown above.*

Large Plastic Moldings Find Practical Applications in Many Fields

New developments and increased confidence in plastics as engineering materials have resulted in their widespread use for large components.

by JOHN DELMONTE, Consulting Engineer

● IN RECENT MONTHS there has been a significant trend toward large plastic moldings, influenced by the increasing confidence of design engineers in the properties of plastics and the availability of adequate equipment for processing large components. In particular, substantial progress has been made in plastic moldings for radio-television, aircraft and refrigeration units. Sizes of some of these components have surpassed earlier efforts by a considerable extent, and there is every reason to expect that this trend will continue in many other fields, now that the practicability of large plastic moldings has been convincingly demonstrated.

In reviewing developments which have led to large plastic moldings, it will be observed that large plastic components fall into three important categories:

1. Large compression moldings
2. Large injection moldings
3. Reinforced plastic moldings

Large Compression Moldings

Interest in large compression moldings has been strong for a number of years and, although limitations in the flowability of materials and press capacities prevented most molders from producing really large compression molded parts, there have been noteworthy examples in past years which have elevated plastics from the realm of small utilitarian articles. Perhaps one of the largest pieces to receive attention before World War II was the urea plastic scale housing, which was first produced in one single housing and then in a number of parts which were assembled together. It is significant that, after ten years, these parts and their assemblies still possess good serviceability.

Another example is the large circular disk employed for card filing purposes. Molded of impact resistant phenolic, it has enjoyed large scale production and has had many successful applications. Recently, however, attention has been focused upon phenolic plastics, which have been used for such products as television cabinets in the form of one-piece moldings weighing up to 40 lb. in some designs.

Much of the credit for the new and large compression moldings must be given to improvements in flowability of some of the thermosetting molding compounds and in the preparatory measures which ready them for the molding operations. The 1000- or 2000-ton presses which are required for the operation are not new, and the design and manufacture of steel molds for very large parts, represent an extension of well proven skills acquired in molding smaller components. However, because of the difficulties encountered in achieving uniform material distribution in a large mold, it has been necessary to introduce new measures to assist flow distribution. Among these are the application of basic design principles upon the molded part, the development of material with improved flow properties, and preheating measures which have given molding materials greater plasticity during the molding operation.

It is not the purpose of this article to review at length the importance of well streamlined flow paths, generous fillets, radii and corners, and gradual transitions from wall sections of varying thicknesses. However, all of these are important measures which assist good flow and help to minimize flow marks in molded parts. Of particular interest is the development of thermosetting molding compounds which require lower pressures during molding. These compounds enable custom molders to mold larger pieces than ever before upon the same press equipment, although in dies with a larger cavity area.

Some of the compounds requiring lower molding pressure are blends of phenolic resins and butadiene-acrylonitrile synthetic rubbers. This is a particularly fortunate combination, because it not only means that improved flow is obtained during molding, but also that the final product will reflect the presence of the rubber component in improved physical properties, notably impact strength. Because large compression molded parts may be subject to much abuse and are relatively expensive to repair if broken, the higher impact resistance offers a distinct advantage. It also implies that elongation will be greater and moduli of elasticity will be lower. Again, these are significant design advantages which may encourage further developments in the direction of large compression moldings.

Although bodies with a lower moduli of elasticity will deform more readily under an applied stress, it must be remembered that various products possess definite advantages because of these lower values. The moduli of elasticity of thermosetting plastics vary from 800,000 to 1,500,000 psi., while the rubber-modified types possess moduli down to 200,000 psi. Compared with steel and aluminum alloys, the moduli are small—but this has not proven to be a handicap. For example, the following design advantages can result from the lower moduli of elasticity which characterize some of the larger molded parts:

1. Because of their distinctly different moduli, the moldings can accommodate larger metal inserts which

tend to create conditions for internal stress. Moldings which yield more are less likely to crack.

2. Molded parts can be "sprung" or yield sufficiently to permit snug assemblies. Fitting parts or dissimilar materials generally entails difficulties that are overcome when one material will bend more readily.

3. Vibration stresses which tend to create noises or disturbances in sheet metal parts are considerably dampened by their plastic equivalents. This would suggest potential applications of plastic moldings in housings for fans, air conditioning equipment, grilles, etc.

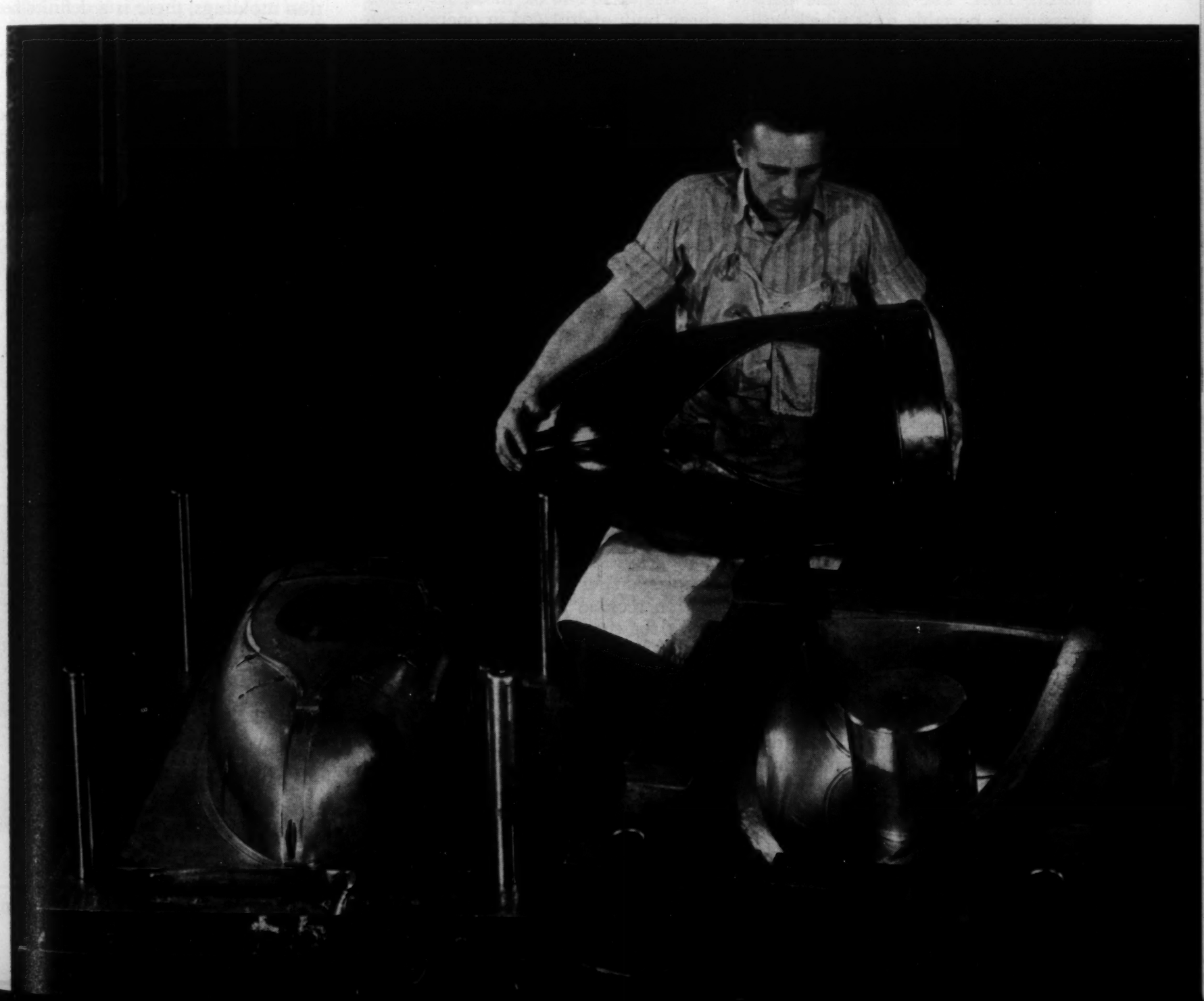
These particular design advantages must, of course, be balanced against tendencies to cold flow and creep, which are more pronounced in materials of lower moduli of elasticity. However, the above advantages are definitely to be considered for the easier flowing thermosetting materials intended for large compression moldings.

Another contributing factor to the success of molding large compression molded parts is the technique of preheating thermosetting plastics. This phase of material processing has commanded much attention recently because it has altered concepts of compression molding processes. The heating of thermosetting plastics rapidly in the presence of a high frequency alternating current field, while not a new concept, has been delayed in its application to dielectric heating until fairly recently. The results are generally recognized to be quite remarkable and, aside from reducing the total cure time (particularly for thick molded parts), high frequency heating has reduced press closing pressures and press closing time. It thus becomes possible to produce larger moldings in a press of limited tonnage. In the accompanying illustration showing the molding of television cabinets, the high frequency preheating unit adjacent to the press provides the source of heat for bringing the temperature of the molding materials close to the mold temperature and, most important of all, to a state of plasticity where it will respond readily to the application of molding pressure.

With the design of larger molded parts goes the design of large molds and greater tooling costs for the prospective customer. A large molded speaker housing and its mold are shown in an accompanying figure. Of course, this type of tooling will turn out many thousands of parts with the utmost fidelity—it is one of the cardinal advantages of the molding process.

Also to be considered in any discussion of large compression moldings is the fact that finishing problems will be accentuated. It is no

This massive mold is used for producing the 14-lb. phenolic plastic speaker housing shown in the workman's hands. (Courtesy Chicago Molded Products Co.)



Before entering the press, the molding materials for these television cabinets are heated in a high frequency preheating unit (left) which raises their temperature close to that of the mold. (Courtesy Bakelite Corp.)

longer the case of a woman operator holding a part against a buffing wheel and removing traces of flash or mold parting lines. The size of the parts necessitates portable tools which will cover the surface and accomplish finishing operations usually performed by stationary machines.

Because there is a greater piece investment tied up in a large compression molding than in smaller components, greater efforts are made to salvage larger pieces with surface defects that could mar their appearance. Thick flash lines are more apt to occur on larger pieces, and their elimination, while posing a greater problem, should be undertaken to avoid scrapping the part in question. In repairing cracks and breaks, good cements are available which will do an outstanding job in producing a strong, permanent bond. Notable among such cements for thermosetting plastics are the low temperature setting furane adhesives produced by Furane Plastics Co. in Glendale, Calif. Resorcinol types are also effective in bonding sections of molded parts on phenolic and melamine plastics.

Large Injection Moldings

The growth of injection molding capacity and the size of thermoplastic injection molded parts have become even more spectacular than the history of thermosetting materials. Whereas during World War II, the industry looked forward to 8- and 16-oz. presses (based upon cellulose acetate with a specific gravity of 1.34), attention is now focused upon 60-oz. presses and higher. In fact, presses up to 200 oz. in capacity have been built and placed in operation so that innumerable consumer items, hitherto excluded from an all plastic composition, now have available the means for their production entirely from plastic.

From a production standpoint, a significant trend should be noted at this time—the development of what are referred to as preplasticizing units. In the conventional injection press, the molding pressure and heating take place in one chamber. In the machine equipped with a preplasticizer, however, the material is heated in a separate chamber and then introduced into the path of the injection stroke, which forces the material into the dies. In fact, lower molding pressures are required because of the thoroughly plasticized condition of the material. Hence, lower die clamping forces are necessary. In other words, there are many mechanical advantages resulting from the use of preplasticizing in producing large injection molded parts.

As for the injection molded parts themselves, a typical piece shown in an accompanying figure illustrates the large units that are currently being produced for the refrigeration industry. Large freezer boxes or drawers, covers and panels have been successfully injection molded. Most of the current interest in large pieces appears to lie in the direction of polystyrene, because of its low cost, minimum water absorption, and odorless and tasteless qualities. However, other materials are making a strong bid in the injection molding field, particularly where contact with food stuffs is required. Polyethylene has been one of the best materials for this purpose to make an appearance. However, shrinkage during molding is high and large polyethylene parts have not been too much in evidence, as yet.

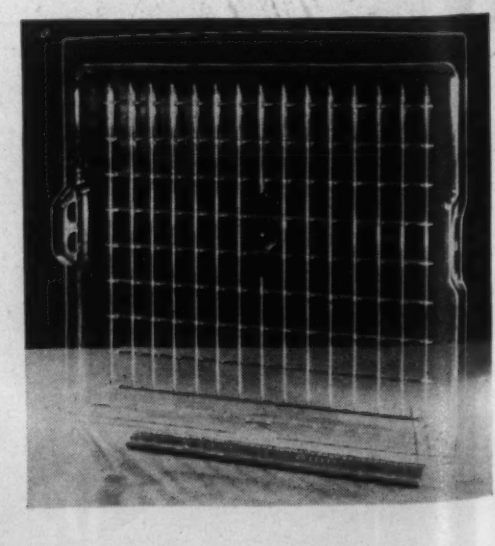
Large injection moldings will tend to introduce their own brand of difficulties. A greater share of attention, for instance, must probably be given to the problems of stress relieving and annealing, processes hitherto reserved for the metals processing industries. While plastics in general do not possess the crystalline structure of metals, there are some which have crystalline tendencies and exhibit first order transitions at certain temperatures. Others are limited more to second order transitions involving rotation or readjustments about the polymer chains. In any event, if stability is to be maintained and crazing tendencies minimized in large injection moldings, there is a definite need for heat treating processes.

Reinforced Plastic Moldings

Perhaps the most original thinking and the most unique developments have appeared in the field of reinforced plastic moldings. Outstanding are the glass fiber reinforced resins which are molded at low pressures. From small tubs to boat hulls, these materials have opened new vistas which have hitherto been considered impractical from the plastics processing viewpoint.

Contributing to the efficacy of the molding operation is a new

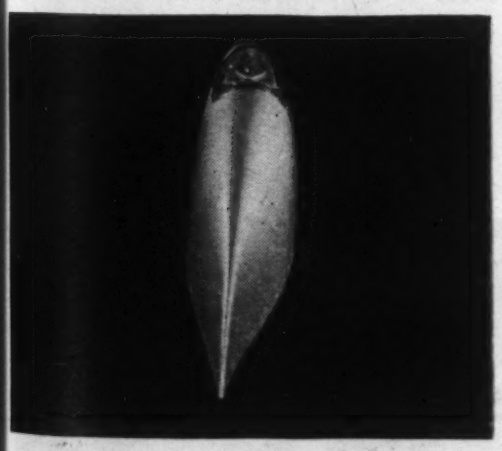
Twenty-six oz. of polystyrene were injection-molded into this 319-sq.-in. refrigerator tray. (Courtesy Hydraulic Press Mfg. Co.)



group of thermosetting plastics identified broadly as polyesters or unsaturated alkyds. These resins are available in a liquid or paste form and, in the presence of heat and catalysts, will change into an insoluble form without the formation of volatile by-products. The splendid phyiscal properties possessed by these resins in combination with those of glass cloth and glass matte have placed non-metallic combinations of this type high on the list of efficient structural materials. Strength-weight ratios are quite high, and superior to those possessed by light-weight aluminum alloys.

Even more important from the standpoint of large plastics moldings are the processing advantages of these materials. While much publicity and emphasis has been placed on the contact pressure at which these materials and their molded components can be cured, the fact remains that larger production parts are being produced at higher pressures, perhaps up to 500 psi.

There is no doubt that appearance and uniformity is improved by the application of good metal molds, handled in hydraulic presses. In fact, it is significant that a number of the better known large compression molders have already undertaken activities in reinforced plastics molding, applying their skill with tools and molding operations to a growing field. Because resinous binders are liquid or paste-like to begin with, high pressures to obtain sufficient flow, as in



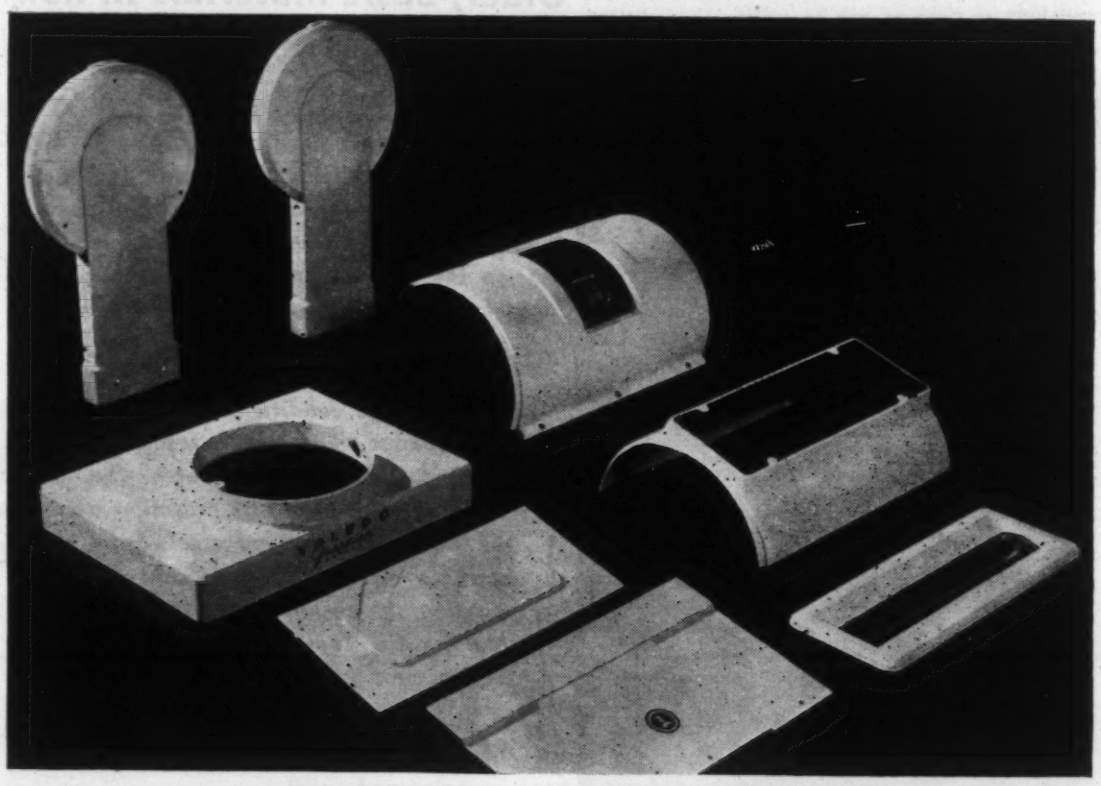
This wingtip is typical of the many aircraft components formed from laminated plastic sheets and molded from glass fiber reinforced plastics. (Courtesy North American Aviation Corp.)

conventional compression molding, are not necessary.

The problems introduced by reinforced plastic molding are largely those of fiber distribution. One successful method prepares preforms of glass fibers with vacuum screen techniques, where a shaped screen builds up the input of glass fibers to the desired contours. This is followed by placing the preform into the mold cavity, introducing a predetermined amount of liquid resin and closing the mold.

While on the subject of reinforced plastic molding, it should also be noted that paper pulp preforms, employing a wet lay-up technique, and sisal fiber preforms, employing a dry lay-up technique, have also achieved prominence in the production of large compression moldings. However, current interest appears to be dominated by the polyester-glass fiber process. An interesting sidelight to this development is the fact that lower molding pressures may be required for boat hulls or radomes for aircraft. Hence, lower pressure tooling, such as nickel electroformed tools have been used quite successfully, in lieu of fabricated metal dies. In practice, the part to be formed is prepared as a cast plastic pattern, upon which nickel plating is deposited until a ¼-in. layer is built up. This shell, perfectly contoured, is reinforced by cast zinc alloy or sprayed metallic iron. It serves as a method for producing large contoured molds, too expensive to make by machining processes. Vertical tail surfaces for aircraft, ailerons and radomes have been successfully produced in reinforced plastic moldings using nickel electro formed tools.

A representative example of glass cloth reinforced plastic component is shown in an accompanying illustration. It is expected that many developments of this nature will make their appearance during the coming year, inasmuch as they combine the good properties of several materials. It should be emphasized once again, however, that the parts will only be as good as the tooling from which they are prepared. Low cost plaster tooling, while successful in the past for single pieces, is not suitable for production unless it has been reinforced or replaced with a metal equivalent. Examples of complete furniture pieces, cabinets, boats, sinks, tubs, and many parts hitherto the undisputed realm of metal processing have been successfully produced in reinforced plastic molding.

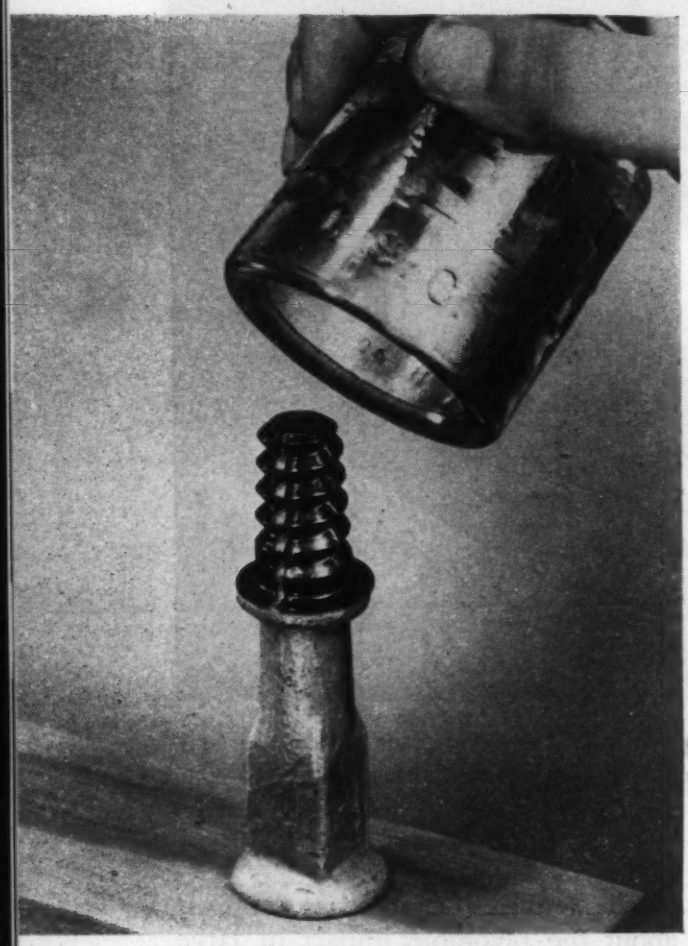


One of the largest plastic products before World War II was this 8-piece plastic assembly of the Toledo Scale housing molded of urea formaldehyde.

Much of this article has centered about the favorable impact of large plastics moldings on the industrial scene. It should be pointed out, however, that these large sections of plastics have many shortcomings which create serious production problems. In many instances, combinations with metals will solve the problems, which are primarily those of providing sufficient strength where it is most needed. Thoughtful planning of components of metal and plastics in juxtaposition will lead to optimum design combinations. This article has been written with the thought of calling attention to the fact that there are materials and processes available for translating plastics into large consumer items. Imagination and willingness to pioneer are needed to forward this trend.

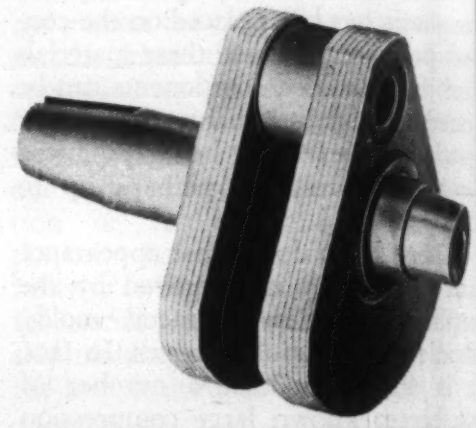
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



MOLDED PLASTIC BUSHING

This molded Tenite plastic bushing has proven successful in reducing breakage of glass telephone-line insulators mounted on steel insulator pins. Screwing the glass insulator on the pin without the bushing results in high stress concentrations in the comparatively fragile and unyielding glass. Subsequent loads imposed by telephone wires under service conditions increase the risk of breakage. The tough, resilient plastic bushing, however, eliminates the high stress concentrations by providing a cushion between glass and steel. Split vertically to provide for expansion and contraction, the bushing is molded by Boonton Molding Co. Tenite plastic is a product of Tennessee Eastman Corp.

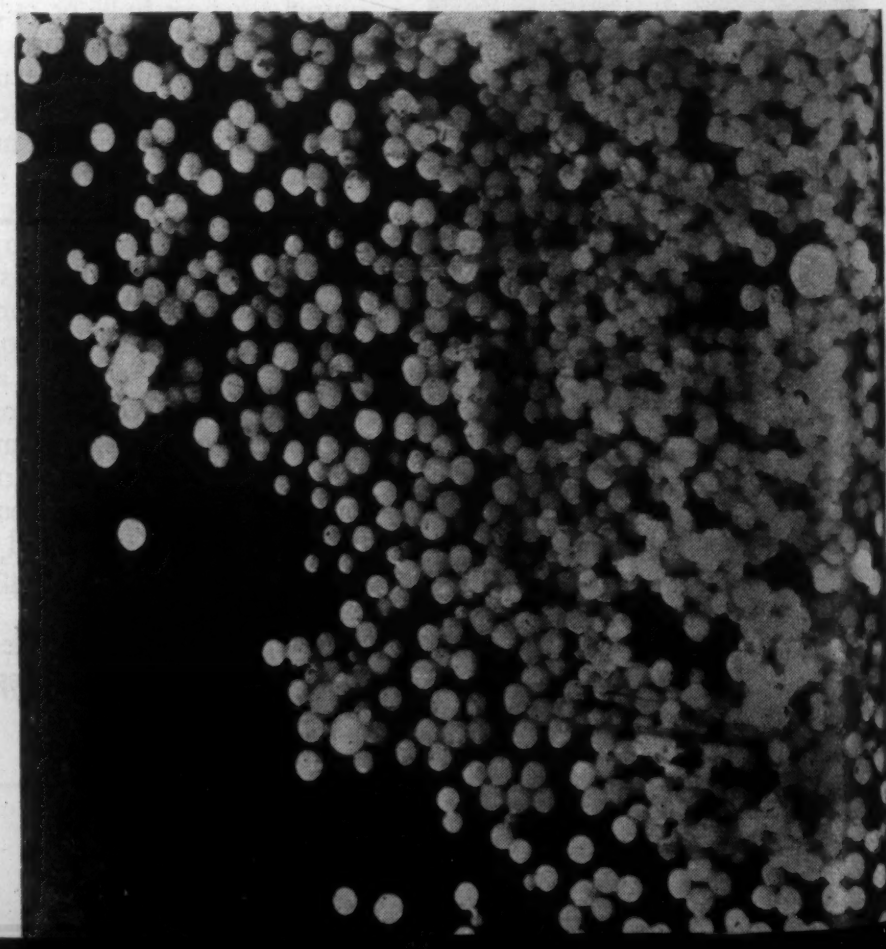


COPPER BRAZED CRANKSHAFT

Use of copper brazed crankshafts, instead of the usual drop forgings, results in substantial cost reductions in many applications—without sacrifice of quality. In fact, operating characteristics are sometimes better than those of conventional design. Either hardened or unhardened shafts are made to desired specifications by Technical Metal Processing Inc., of Cleveland.

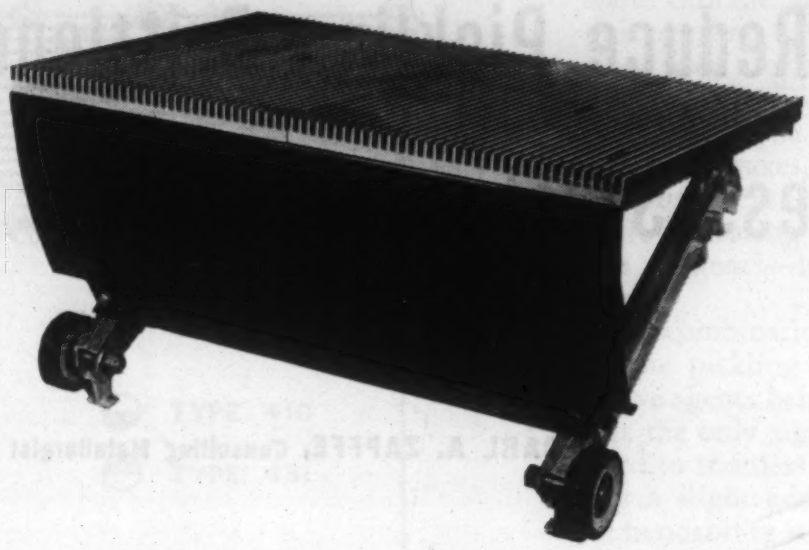
WATERPROOF COATINGS

Radically improved types of waterproof, water-thinned, emulsion-type coatings are based on particles of Bakelite styrene resins so small that they can only be seen through an electron microscope. The uniformly tiny particles form a base for coatings that are easy to apply and are extremely quick-drying and durable. Each of the spherical plasticized particles is about 4 x 10^{-6} in. in dia. This electron microscope photograph shows them at 50,000 times actual size. Paints and coatings based on the new Bakelite styrene emulsions are resistant to moisture, soap, alkali, acid and chemical fumes.



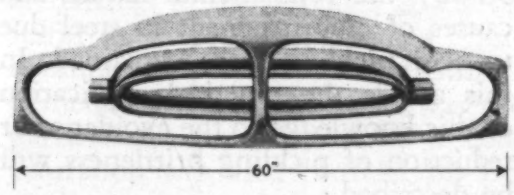
ENAMEL-FINISHED ELEVATOR RISERS

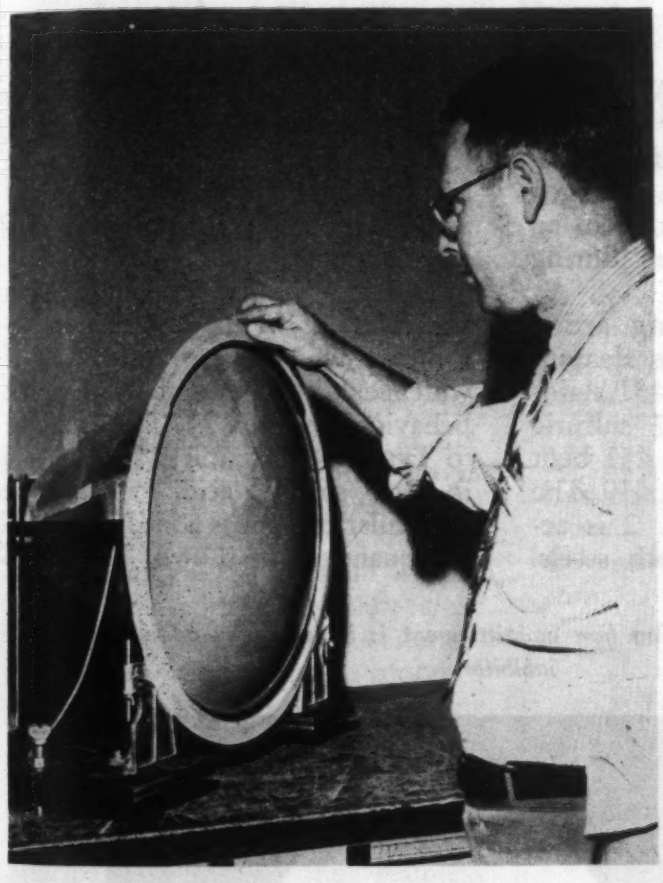
Porcelain enamel proved to be the best material when Otis Elevator Co. specified a black, highly abrasion resistant, permanent, low gloss finish for this escalator riser. Bettinger Enamel Corp. succeeded in making the risers with less than 1% rejections on production runs despite the following intricate engineering problems involved: (1) the enamel finish, in two coats, had to be between 0.006 and 0.007 in. thick; (2) enamel slip had to be kept at static consistency; and (3) two drying-firing-cooling cycles were involved—with firing temperature at 1500 F.



AUTOMOBILE GRILLE

Another example of the versatility of die casting is this new automobile grille, designed by Doehler-Jarvis Corp. engineers in collaboration with Packard Motor Car Co. Made of zinc, the grill measures 60 in. in width and is the largest automobile grill in overall area ever die cast.



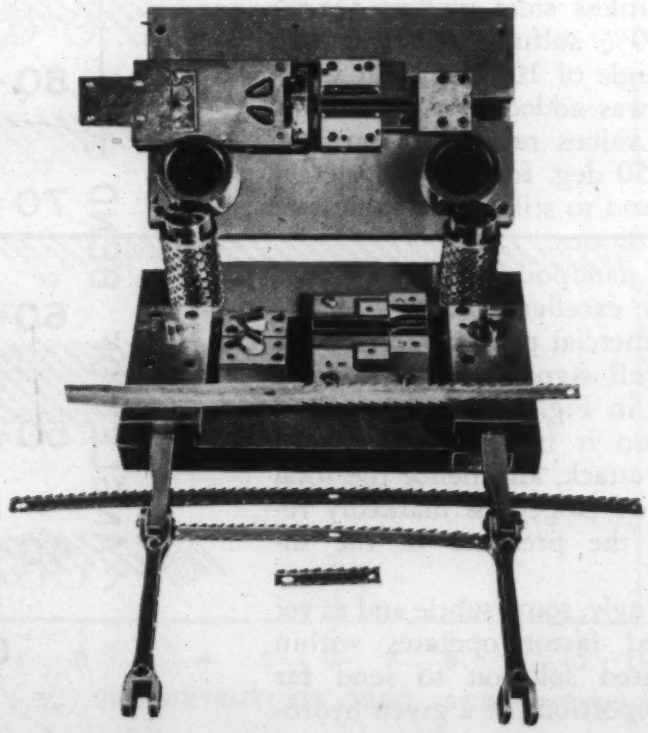


CURVED EXTRUSION

General Electric Co.'s new 19-in. television receiver uses a polyethylene plastic mounting ring to insulate the metal picture tube electrically. The ring, patented and supplied by Anchor Plastics Co., of New York, is a curved extrusion—manufactured by a process which produces a curved shape free from distortion and the tendency to straighten out again. On the receding conical body of the tube is a sleeve of the same plastic, which completes the insulation. Circular, elliptical, and other curved shapes for frames and mounts can be extruded to a maximum diameter of 3 ft.

CARBIDE DIES

Use of these carbide dies for both blanking and forming channel-shaped saw bands for cotton cleaning machines is speeding up production at John E. Mitchell Co. of Dallas, Tex. The steel blanking dies formerly used had to be sharpened at least once a day during periods of rapid production. But the new Carboloy blanking die performs 20,000,000 blanking operations—a full year's operation—before sharpening is necessary. It is estimated that the life of the blanking portion of the die will be at least 100,000,000 blanks, compared with the 1,500,000 blanks for comparable steel dies—a 65-fold increase in service life.



How To Reduce Pickling Brittleness in Stainless Steels

by CARL A. ZAPFFE, Consulting Metallurgist

Investigation of pickling inhibitors, surface active agents and foaming compounds has provided valuable information on ways to avoid or reduce embrittlement.

● IN A PREVIOUS ARTICLE (MATERIALS & METHODS, Oct. 1950, pp. 58-62) the fundamental nature and causes of embrittlement in steel due to acid pickling were explained. In this article the practical application of this knowledge to the avoidance or reduction of pickling brittleness will be described.

Pickling Inhibitors

Undoubtedly the most astonishing result of all the research in this field to date—and probably the most important so far as commercial pickling operations are concerned—is the discovery[1] of the increased embrittlement of stainless steel caused by adding an inhibitor to the pickling solution.[2] In Fig. 1, bend data for a prominent commercial inhibitor express this phenomenal reaction. Type 440-C stainless steel pickled for 15 min. in 10% sulfuric acid fractured near an angle of 100 deg.; but when inhibitor was added to the solution, the bend values rapidly dropped to less than 50 deg. for the proprietary addition, and to still lower values for further additions.

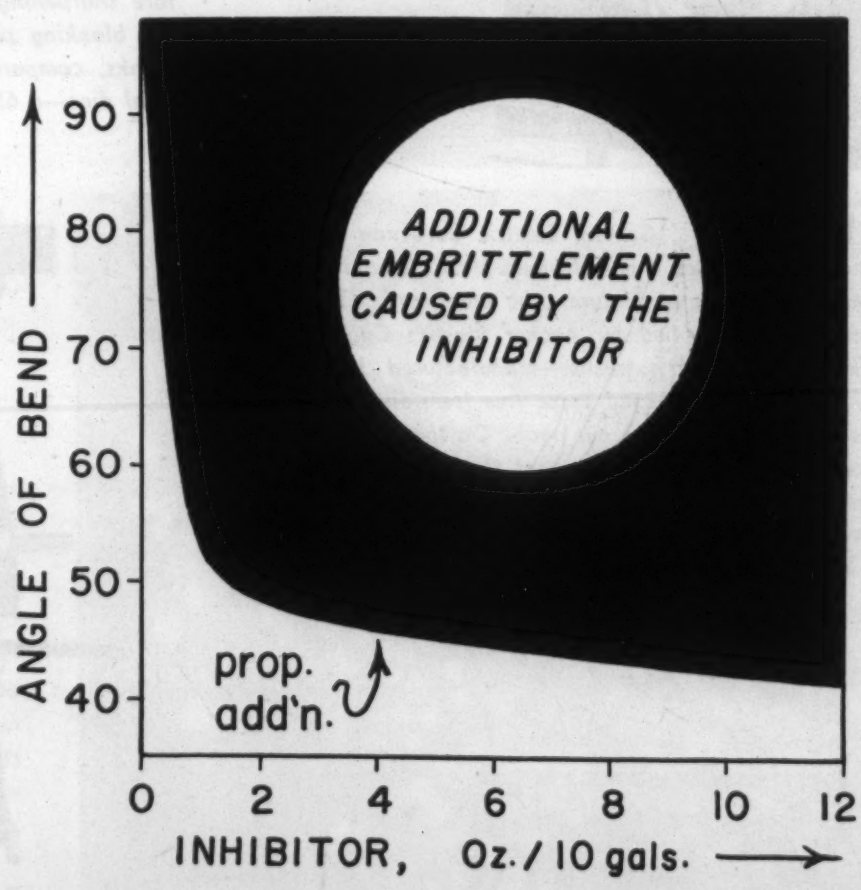
From a standpoint of metal attack, this is an excellent reagent, as are most commercial pickling inhibitors; and the full significance of the information in Fig. 1 will only be realized when it is remembered that the metal attack, and hence the total hydrogen developed, is markedly reduced by the presence of the inhibitor.

Accordingly, some subtle and as yet unidentified factor operates within the inhibited solution to send far greater proportions of a given hydrogen supply into the steel. With perhaps only 1% or less of the total hydrogen developed, this factor accounts for sending more hydrogen into the body of steel pickled in an inhibited bath than occurs during pickling in raw acid.

In Fig. 2, this damaging action of commercial inhibitors is demonstrated for Types 410 and 431 stainless steels. The acid is 10% sulfuric at 170 F. In the test, Type 431 bent a full 180 deg., as did Type 410. The "blank" bend value in Fig. 2 is accordingly 180 deg. for both steels. Immediately, with the first additions of an inhibiting reagent, both of these steels show embrittlement, the bend angles falling to values as low as 60 deg. when a proprietary addition is used.

In Fig. 3, similar results are shown for five out of 14 commercial inhibitors which were tested, all of which exhibited essentially the same behavior (see Ref. 2). The data refer to Type 440-C stainless steel pickled in 10% sulfuric acid, to which the particular reagent is added in increasing quantities as shown. The shaded

Fig. 1—Bend data showing how embrittlement is increased by adding an inhibitor.



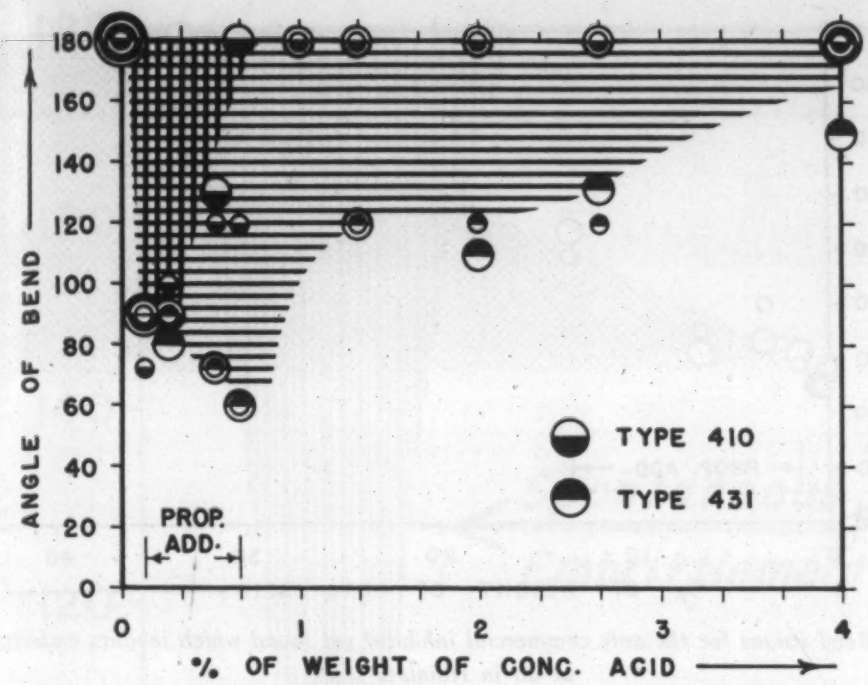


Fig. 2—This chart shows damaging action of commercial inhibitors on Types 410 and 431 stainless steels. The acid is 10% sulfuric at 170 F.

area designates for each inhibitor the further loss of bendability beyond that caused by pickling in raw acid.

In Fig. 4, there appears the only data so far known for a commercial reagent showing any improvement of embrittlement at all in the pickling of stainless steel—a special reagent developed in the course of the research and now marketed by the American Chemical Paint Co. as Rodine 250. Even this inhibitor leaves something to be desired, but it is the best that has been found.

In closing the remarks on inhibitors, it is important to make clear that: (a) the evaluation of commercial reagents in this research concerns aspects of hydrogen embrittlement only, and has nothing to do with other features of the inhibitor; (b) the phenomenon of increased embrittlement under present discussion principally concerns the stainless steels. These reagents have all been developed specifically for problems with carbon and low-alloy steels, having been more or less extrapolated to application for stainless steels. The problems are distinctive for the two classes of steel, and are much more severe for stainless steel.

Nevertheless, the behavior with carbon steel differs widely in many cases from conclusions that might be drawn on the basis of efficiency in preventing metal attack, and hence development of hydrogen. A few commercial reagents actually increase embrittlement in mild steel; most of them improve the condition to greater or less extent; and some are particularly excellent. The details can be found in Ref. 2.

Surface Active Agents

Certain chemical reagents are sometimes added to pickling baths to increase the wetting power of the solution. Termed "surface active agents", or detergents, these chemicals may importantly modify the embrittling process. In Ref. 3, details on a number of such reagents can be found.

Once again, an anomalous behavior develops for stainless steels, in contrast to carbon steels. Neither anionic, cationic or nonionic classes of these chemicals have any effect upon the embrittling of stainless steel, whereas some cationic and virtually all nonionic reagents show an inhibiting action with carbon steel. This latter effect is particularly interesting in the case of the polyethylene glycols and carbowaxes, where inhibition of embrittlement increases importantly with increasing molecular weight of the reagent[3]—but only for carbon steels.

In combination with an inhibitor in the pickling solution, the surface active agents behave differently again; but the only significant data with regard to stainless steel are those showing a slight additional improvement in bendability when used in combination with the special stainless inhibitor, Rodine 250. In the presence of other inhibitors no effect is noted one way or the other.

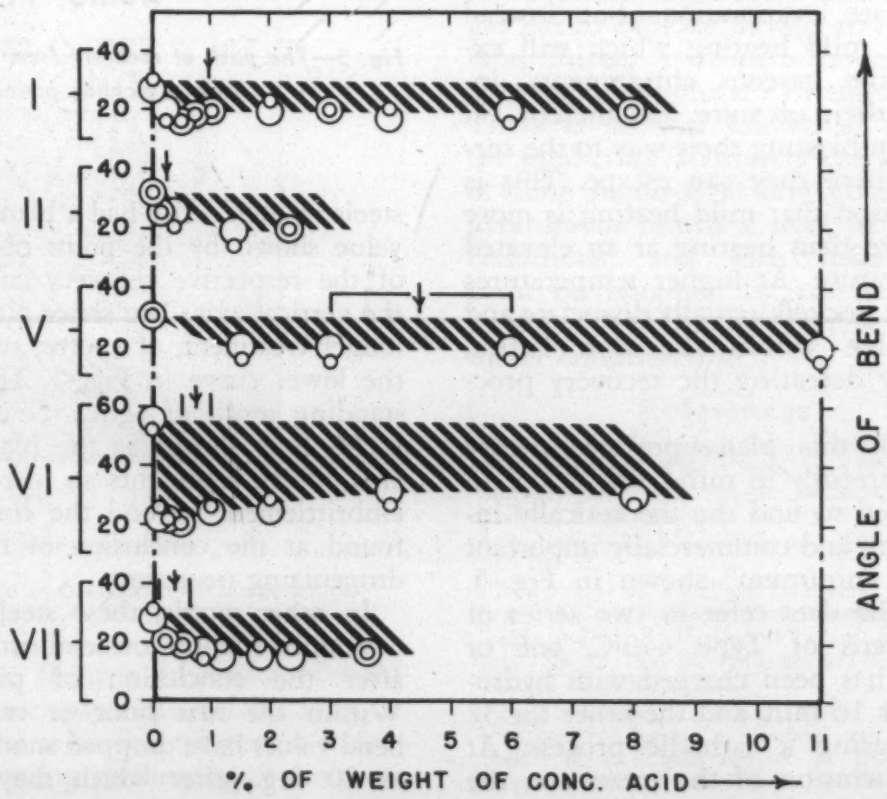
Foaming Compound

Only one foaming compound has been tested[3]—a sulfite pulp waste liquor. As might be expected in view of remarks in the previous article on sulfur as a "promoter element", this foaming compound increased embrittlement. However, the effect was not particularly important until a concentration was used considerably exceeding customary additions.

Molten Caustic Pickling

No thorough investigation of molten caustic baths, such as "Virgo" and the Du Pont Hydride, was conducted; but a few tests with the latter

Fig. 3—Data for five of 14 commercial pickling inhibitors tested on Type 440-C stainless steel in 10% sulfuric acid.



process showed no detectable embrittlement. In fact, Type 440-C stainless previously embrittled in sulfuric acid nearly regained its initial bendability during subsequent treatment in the hydride tank. This improvement is an expected effect of the heating; and the hydrogenizing conditions of that bath are evidently too weak to mask the recovery.

Aging and Recovery

Although the best advice is to keep hydrogen from entering the steel, it is also an important matter to know how to remove it. Much has been written on recovery, some of which is in error; but it is generally recognized that mild heating removes the gas.

As for the manner in which hydrogen is best removed from steel, one must learn to understand the fundamental process along the general lines described in the previous article. The principal contribution to an understanding of recovery lies there in the description of planar occlusion, and the manner by which the gas collects in microscopic pockets and travels throughout the steel by diffusion of these minute and highly compressed gas inclusions. "Occlusion-diffusion" is a good descriptive term for this unique phenomenon.

Consequently, to remove the gas, one must fix his attention more on a mechanical picture than a chemical one. That is, the gas does not so much evaporate uniformly as atoms from the steel as it does explode in bursts of molecular accumulations; and the most effective means for removing the gas is accordingly not a vacuum and a high temperature—designed to accelerate evaporation—but instead merely mild heating which will expand the gaseous entrapments, increase their pressure, and thereby aid them in blasting their way to the surface where they can escape. This is the reason that mild heating is more effective than heating at an elevated temperature. At higher temperatures the gas pockets actually dissociate and redissolve within the iron lattice, thereby defeating the recovery process.

With this planar-pressure theory kept carefully in mind, one is not so surprised to find the theoretically interesting and commercially important "aging minimum" shown in Fig. 5. Here the data refer to two series of specimens of Type 440-C, one of which has been charged with hydrogen for 16 min. and the other for 32 min., using a cathodic process. At the conclusion of the treatment, the

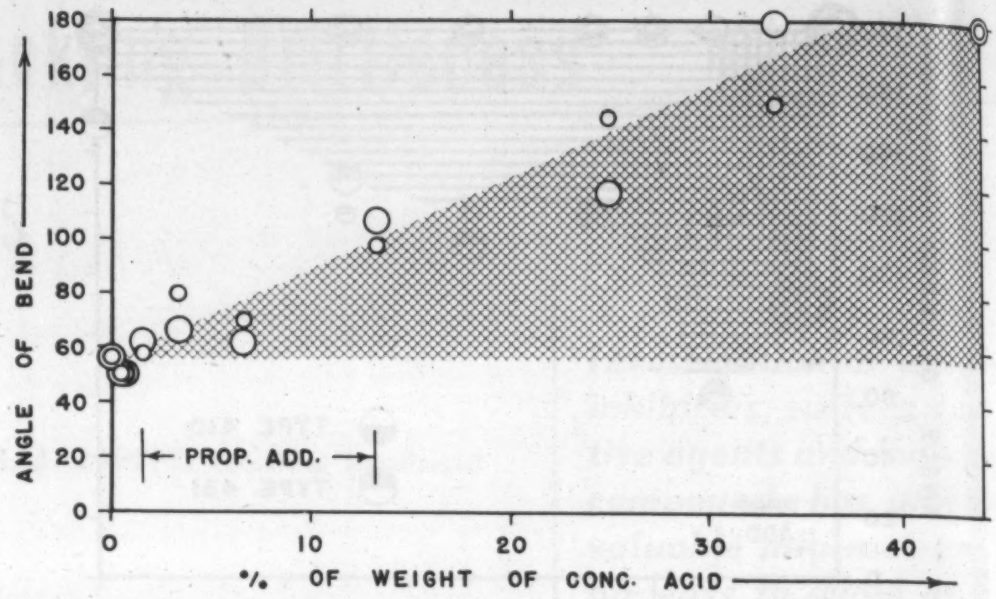


Fig. 4—Bend values for the only commercial inhibitor yet found which inhibits embrittlement at all in stainless steel.

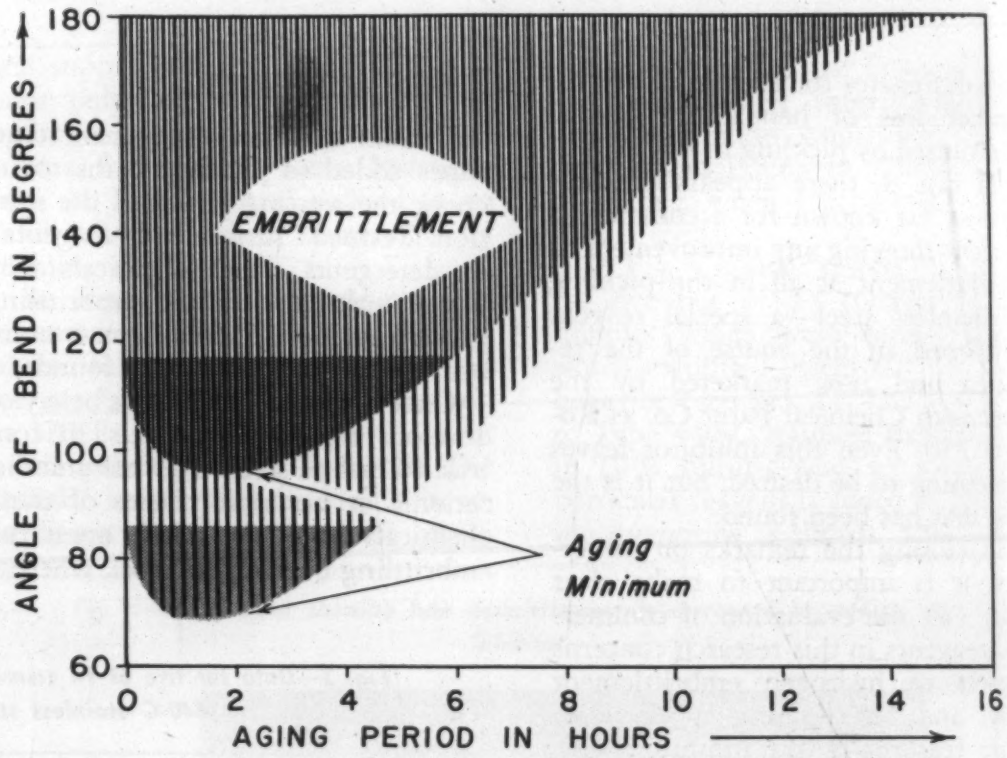


Fig. 5—The path of recovery from embrittlement of Type 440-C stainless. The lower curve is for a pickling period twice as long as that of the upper curve.

steels in each series had a blank bend value shown by the point of origin of the respective recovery curve on the vertical axis. The series given the longer treatment, of course, refers to the lower curve in Fig. 5. The outstanding result of aging these series at 86 F is shown as the blackened area, which represents an increase in embrittlement beyond the condition found at the conclusion of the hydrogenizing treatment.

In other words, these steels have developed spontaneous embrittlement after the conclusion of pickling. Within the first hour or two, the bend values have dropped another ten or 20 deg., after which they again increase, finally attaining a full bend of 180 deg. in 14 to 16 hr. Parallel series conducted at temperatures from 32 to 356 F uniformly showed this same aging minimum. A particularly striking example is shown in Fig. 6. Here specimens have been charged with hydrogen for such a brief period of time that they still bend 180 deg. at the conclusion of charging. Aged for 1 min. in boiling water, the specimens then fractured at angles near 100 deg.; but after 2 min. in boiling water, they again exhibited a full bend. The shaded area in Fig. 6 accordingly shows embrittlement which has developed spontaneously in specimens showing no loss of ductility at

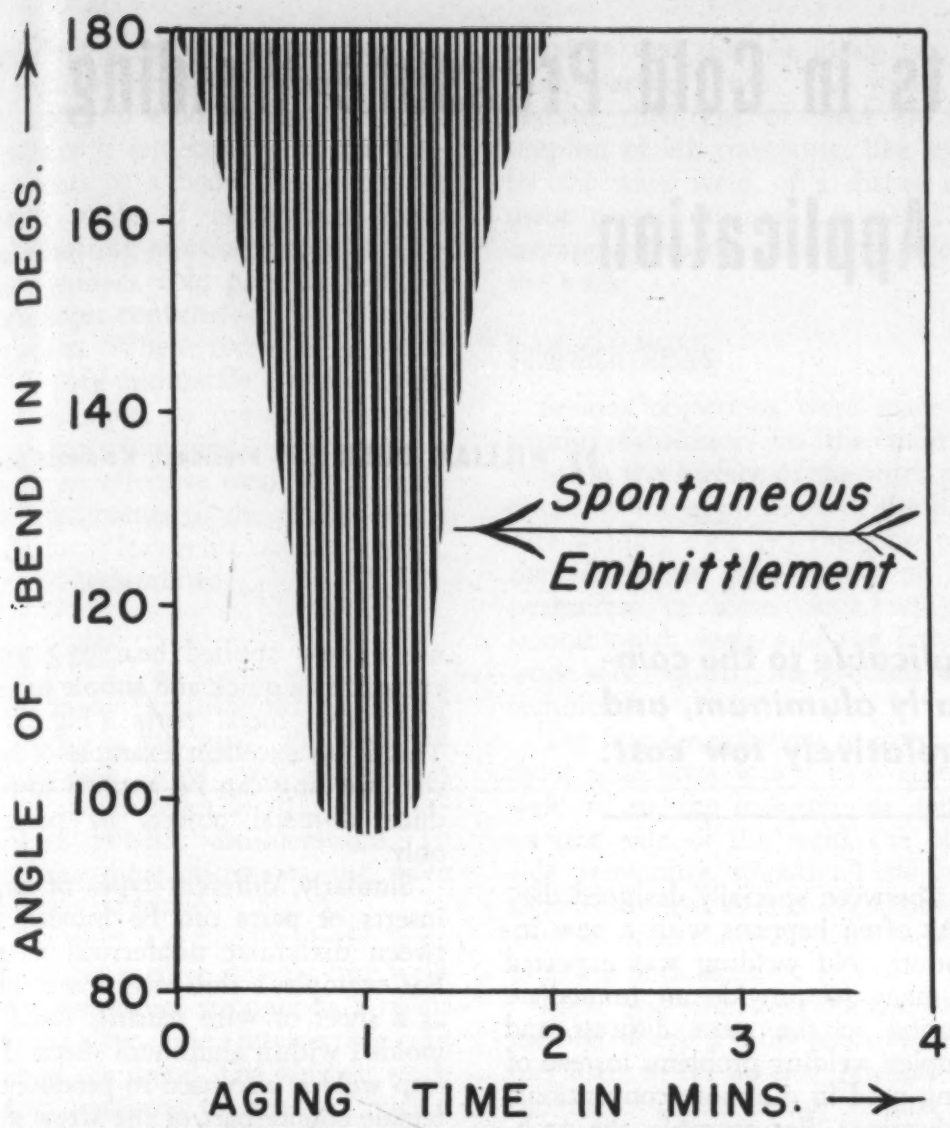


Fig. 6—A particularly pronounced instance of the "aging minimum" showing spontaneous embrittlement.

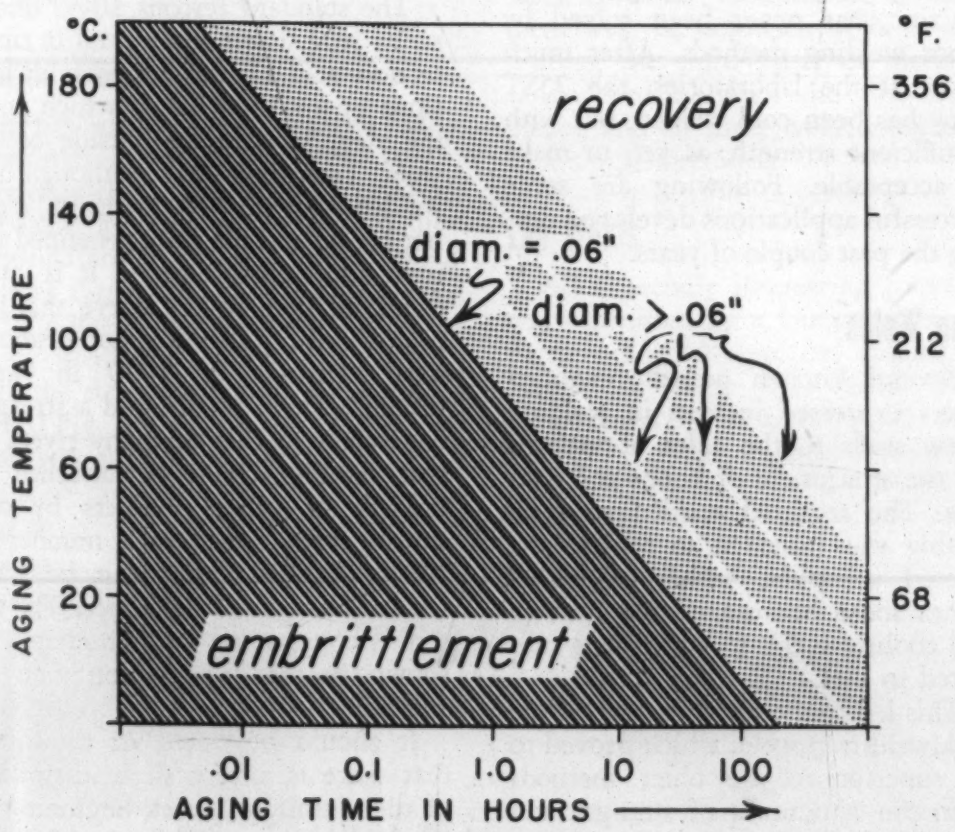


Fig. 7—Time required for recovery of a 180-deg. bend as a function of temperature.

the immediate close of the pickling treatment.

This aging minimum is an important phenomenon for practical reasons. Many a fabricator of hardened steel parts has had cracking develop at some delayed period following pickling or cleaning of the piece. The same is true of electroplated articles—in perfect condition at the conclusion of the plating operation, but developing cracking at some later date; and it is common knowledge in the heat treating of hardened steel that the piece must be tempered immediately to prevent cracking. While this is not the place to discuss cracking of tempered parts, the delayed cracking obtained in such pieces is closely similar to the hydrogen phenomenon of an aging minimum, and is probably often much more closely related than is commonly believed. The aging minimum is the result of the fact that hydrogen embrittlement is a precipitation process, requiring time for hydrogen atoms charged into the lattice to diffuse, precipitate and accumulate under damaging pressures.

Finally, in Fig. 7 the recovery of embrittled steel is depicted as a function of time and temperature; also thickness of the specimen. The heavily shaded area expresses embrittlement occurring in 0.06-in. Type 440-C specimens given a standardized embrittling treatment and aged at temperatures and for periods as shown. The boundary of this heavily shaded field represents the time required at a given temperature for the recovery of a full bend of 180 deg. Curves similar to those shown in Fig. 5 were obtained for a number of temperatures, the only difference being in the aging period necessary for recovery. These are estimated in Fig. 7 as adjoining boundaries at greater aging periods for specimens of greater thickness. The relationship of temperature and time is remarkably uniform for a given steel and given size of specimen. However, because the gas has to explode its way to the surface, thicker specimens understandably require appreciably longer times. There is no way known at present for predicting accurately the amount of time required at any given temperature to return a steel to ductile conditions; and such information must be obtained by conducting a series of tests on the specific article under consideration.

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[2] "Evaluation of Pickling Inhibitors from the Standpoint of Hydrogen Embrittlement." C. A. Zapffe and M. E. Haslem, *Wire and Wire Products*, Vol. *23*, No. 10, 1948, pp. 933-9; 1048-53, 1080-2; 1126-30, 1172-5.

[3] "The Influence of Surface Active Agents on Pickling Brittleness in Carbon and Stainless Steel," C. A. Zapffe and M. E. Haslem. (To be published in *Trans. Electrochem. Soc.*, 1950.)

Latest Developments in Cold Pressure Welding Widen Its Field of Application

by **WILLIAM DUBILIER**, President, Koldweld Corp.

This unique joining method is applicable to the common nonferrous metals, particularly aluminum, and produces welds quickly and at relatively low cost.

● COLD PRESSURE WELDING, a method of welding aluminum and other nonferrous metals without the use of heat or electricity, was made available in this country late in 1949 by Koldweld Corp., and created great interest in the metal working industry. Developed by the General Electric Co., Ltd. in England, the process is applicable to the common nonferrous metals, particularly aluminum and its alloys. The required welding pressure can be applied manually or by power tools. Use of the simple tools required does not demand special training or the employment of skilled labor. Welds of uniform quality are produced easily, quickly, and at low cost.

Already finding wide application in the metal working industry, the Koldweld process not only replaces other assembly methods in many industrial applications, but, in some cases, produces stronger and better welds. It usually permits additional savings in manufacturing costs through simplification of designs made possible by the special characteristics of the process.

Briefly, cold welding consists of thoroughly cleaning the surface of the metals and then applying pressure over a comparatively narrow strip so that metal can flow away from the weld at both sides. Pressure is applied with either a slow squeeze or an impact between specially designed dies.

As often happens with a new invention, cold welding was expected by many to provide an immediate solution to the most difficult and complex welding problems instead of being used in the more conventional applications. For example, the problem of welding thin sheets of 75ST aluminum, an extremely hard (Brinell 150) alloy with a high percentage of zinc, has never been solved by other welding methods. After much effort at the laboratories, the 75ST alloy has been cold welded, but with insufficient strength, as yet, to make it acceptable. Following are some successful applications developed during the past couple of years.

For a more detailed description of the mechanics of cold pressure welding, see "Materials Joined by New Cold Welding Process" in the Nov. 1948 issue of MATERIALS & METHODS, p. 60.

Trap Welds

Several kitchen utensil manufacturers expressed interest in welding screw studs to the sides of utensils for the attachment of knobs and handles. The required welded stud assembly was intended to replace the riveted assembly, which often becomes loose because of the heating and cooling cycles to which it is subjected in use.

This led to the development of the Koldweld trap weld, which proved to be superior to the older methods from the standpoint of strength and ease of application, as well as lower costs. The screw stud or a threaded insert is now, in effect, an integral part of the utensil. (See Fig. 1)

The fabricated metal form has a metal insert firmly embedded into another metal structure without the use of any applied heat or electric current by a quick and simple process using two metal parts (Fig. 1A). This is an excellent example of how cold welding can be applied to produce all-metal objects by pressure only.

Similarly, different types of metal inserts or parts can be molded between dissimilar nonferrous metals. For example, a thin steel insert, such as a sheet or wire netting, could be molded within aluminum sheets. The trap weld is also used to produce the female counterpart of the screw stud. Several methods were developed (Fig. 1C), each of which leaves the back of the work smooth.

The standard ferrous 10-32 thread screw stud shown at A (and in cross-section at 1A) was tested with tensions up to 1500 lb., at which point the steel stud broke outside of the weld (see Fig. 2). Although the welded joint showed distortion, it did not break, and the joint remained airtight and moisture-proof. It is interesting to note in the curve that the cold welded joint was not distorted until tensions of 1000 lb. were reached. This stud showed a strength equivalent to that of many rivets, so that handles could be attached to utensils or other products by one simple stud instead of a number of rivets. A steel insert can be trap-welded in a similar manner. The insert is constructed with shoulders, as shown in the cross-section view of Fig. 1.

It should be noted in the curve that there is a very slight distortion of the aluminum sheet, beginning at the load of about 600 lb. At 1,000 lb., the distortion is 0.02 in. But a load of more than 1500 lb. and a distortion of 0.18 in. were reached before the steel stud finally broke. These tests show that this type of cold welded joint will withstand more

than three times the tension required to produce the same distortion in a standard stud weld or rivet.

Where it is necessary to make attachments to a body or a container usually made of nonferrous sheets and requiring moisture-proof or pressure-tightness, cold pressure welding is the most convenient way of applying them. Where rivets or gasketed joints may ultimately develop leaks (for example, in pressure compartments for stratospheric operation), it also is an effective method for making attachments to the inside of the body, for it leaves the outside smooth, flat and streamlined.

Wave Welds

In many applications involving welding of flat stock the standard straight-line weld was sometimes found undesirable because of structural or esthetic considerations. To overcome these objections, the wave weld was developed (Fig. 3).

This weld is applied with the same ease as the regular straight-line weld and is somewhat stronger as a result of the wave line intersecting the grain of the metal. The finished work has no tendency to bend or buckle along the weld line. Tools for making this type of weld are very simple, and consist of one shaped element pressing against a flat plate.

Stagger Welds

It has always been difficult and sometimes impossible to weld comparatively thin metal sheets to heavy bar stock, as often is required in the construction of truck bodies, tanks, railroad cars, metal shelving, shelters, and the like. This presented an interesting challenge which was solved with the development of the stagger weld (Fig. 4). It consists of dots or short straight-line welds slightly staggered so that they lie along two or more parallel lines. The tools for making this type of weld are the simplest of all, consisting, like those for the wave weld, of a shaped element pressed against a plate. They are applied to the thin sheet side of the work.

Sandwich Welds

Serious objections were made by various fabricators to the indentations on the surface of the work produced by the application of the pressure welding tool. For the most part, the objections were based on appearances; in some cases, when a smooth-finish surface of the finished work was required, the grounds were technical.

The first development to overcome these objections was a new type of weld where the indentations appear on one side of the weld, the other side remaining smooth. Tests have shown the new weld to be somewhat stronger than the weld with indentations on both sides.

Next was the development of a method where a third piece of metal was used to fill up the indentations, the three pieces being welded together in a single operation. This proved satisfactory and eliminated the pressure tool indentations on both sides. However, the ultimate development was the sandwich weld. In this process, the third piece of metal is sandwiched between the two work pieces, and all three welded together in a single operation.

Lap Welds

An especially interesting problem was submitted by a Government department, which specified the manufacture of large thin-walled sheet metal boxes or containers which were required to be air-tight, moisture-

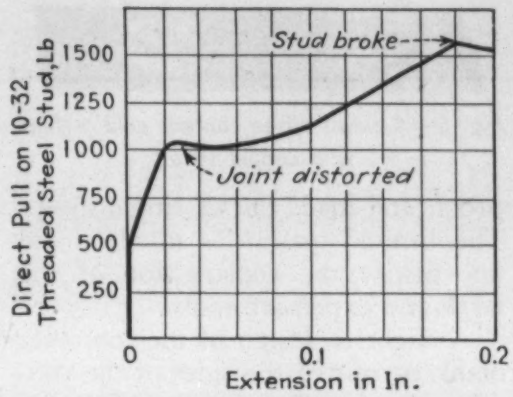


Fig. 2—Curve showing direct load vs. extension of trap weld joint with a standard 10-32 thread screw stud.

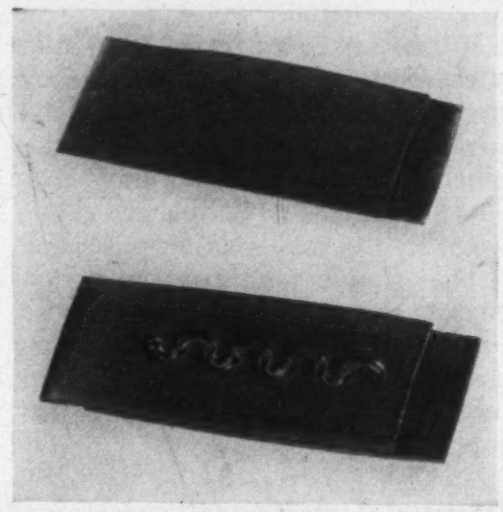


Fig. 3—View of both sides of a wave welded joint.

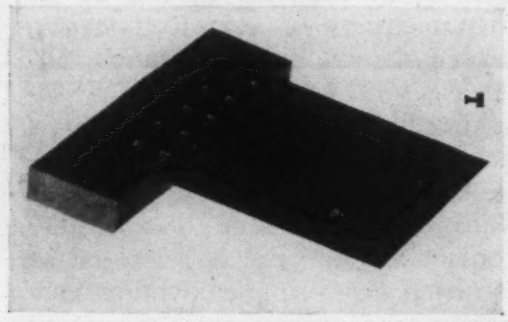


Fig. 4—The stagger weld for welding thin metal sheets to heavy bar stock consists of staggered dots or straight line welds on two or more parallel lines.

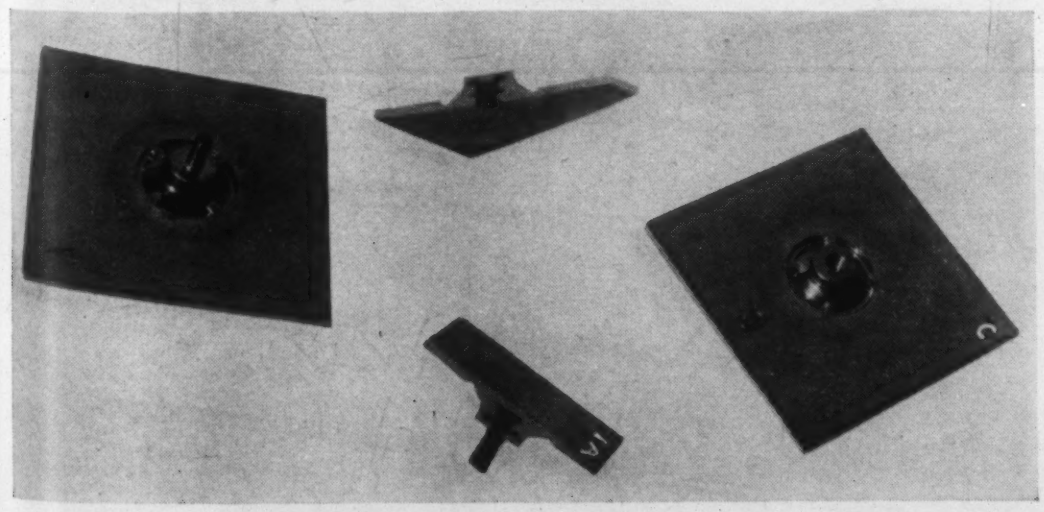


Fig. 1—Typical trap welds made by cold welding.

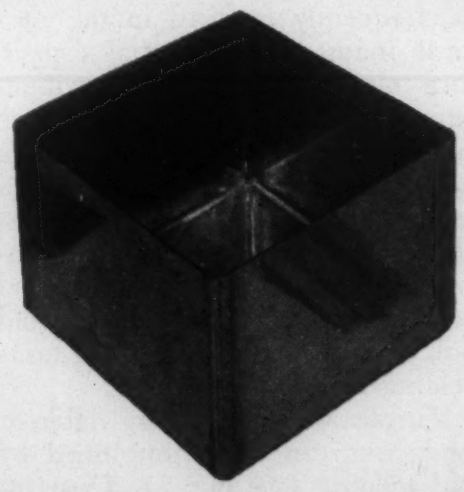


Fig. 5—A thin wall aluminum container fabricated by cold welding using a lap joint.

Fig. 6—A small silver contact cold welded to a copper strip.

proof, and made out of single sheets. The limited quantities involved did not justify the construction of the large and expensive tools.

A slight re-design of the container blank permitted the sides of the container to overlap slightly (Fig. 5), allowing them to be lap-welded to produce the finished container shown.

The resulting lap weld is approximately 1.3 times as strong as the original material.

When boxes are made from thin sheet metal and heat is applied during the process, the sides usually warp and various strains develop which cause other distortion. This working tendency, however, is completely eliminated by the cold welding process.

One simple tool structure design enables the same corner welds to be used for boxes or containers of any size, reducing the heavy casts and large, cumbersome tools required for press operations.

Electrical Contacts and Conductors

Among numerous problems investigated by the General Electric Co., Ltd. laboratories for the benefit of manufacturers of electrical devices, several deserve special mention. Silver electrical contacts, riveted, silver-soldered or brazed to copper or brass bars, are subjected in operation to extreme heat cycles because of arcing. With time, the bond between the contact and the bar is destroyed or loosened. But a simple operation now permits the permanent cold welding of small or large silver and other metal contacts for switches, circuit breakers, relays, and the like (Fig. 6).

The process can also be used in welding heterogenous nonferrous metals, frequently required in the electrical industry. Commercial copper, pure electrolytic copper, beryllium copper, brass, silver, aluminum, lead, nickel, and their alloys, including monel, are easily cold welded each to the other. In addition, it is now possible to cold weld extremely thin nonferrous metal sheets (10 mils and less) by using a simple small hand tool. This is not practical with heat-welding methods.

Various welds on many different conductors can be accomplished by cold welding (see Fig. 7). These include a two-conductor cross-weld, welding a small copper wire to a copper-clad steel rod, welds of two conductors—of the same or dissimilar metals—ferrous and nonferrous, stranded conductors, and pigtailing a conductor.

The Copperweld Steel Co., which supplies heavy copper-clad steel rods for grounding purposes, has developed, under a license from the Koldweld Corp., an efficient method of connecting conductors, making perfect contact, as shown at B in Fig. 7, where a copper-clad steel rod has welded to it a small copper wire. It is interesting to note that, although the pressure was sufficient to distort and displace the steel conductors, a thin layer of copper was always present and the welding took place between the two copper surfaces. The weld proved to be mechanically stronger than the wire itself.

Other Applications

Many other uses for cold welding have been found in various fields. A simple tool has been developed for joining thin metal sheets or strips to increase the length of plate for continuous runs without retreading. Cold welding can also be used for increasing the length of coiled metal for continuous processing.

Cans and other containers made from 0.010-in. aluminum are being developed for an oil company. These containers will have a rectangular shape, which has a great advantage in affording flat surfaces for printing and display advertising.

Large tubes have been made for a musical instrument manufacturer to replace the former extruded resonator tubes used in xylophones, which heretofore had to be polished and carefully handled. Employing cold welding, these tubes can now be manufactured from well-finished sheet-metal stock. Round wooden dowels or rods have also been covered with thin-gage aluminum sheet by this process.

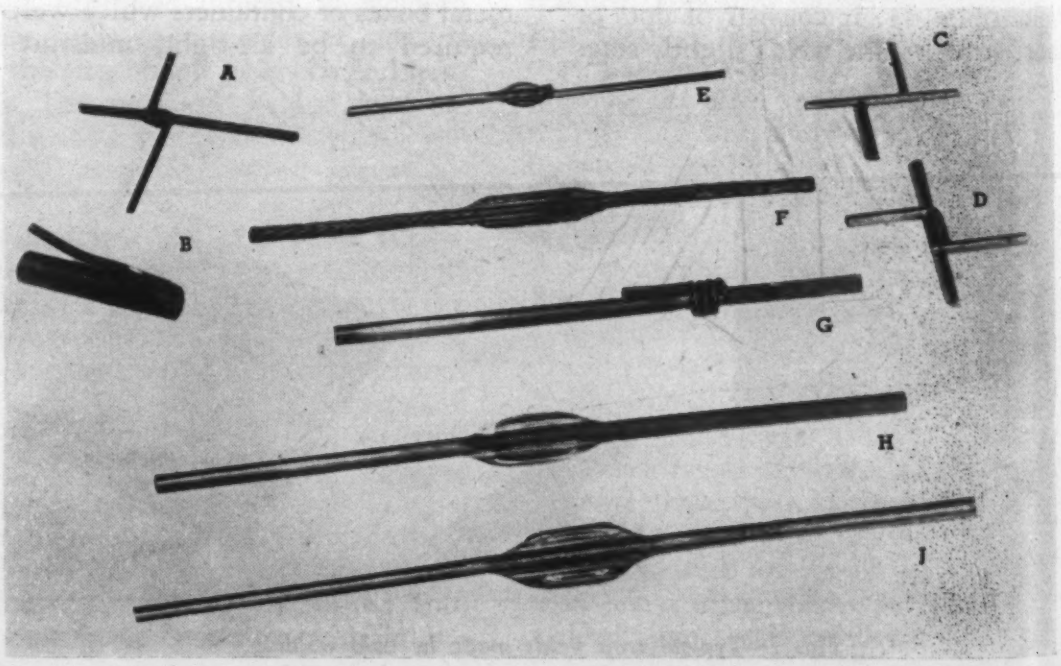
For packaging or sealing various electrical and other units in air-tight, moisture-proof, thin-walled aluminum containers, cold welding methods have been found to be both inexpensive and satisfactory. Collapsible tubes, such as those used for tooth-paste, are end-sealed by cold welding to produce a more satisfactory seal and prevent the contents from seeping through the normal double-edged fold. This tube can be used successfully for oils, perfumes and other compounds marketed in collapsible containers. Aluminum bottles can be easily made by extruding the bottle upside down and the base is then closed by cold welding a circular disk.

For fixing thin plates, such as covered plates to castings and heavy frames, cold welding can be used in the manufacture of radio chassis and other portable units.

A number of companies are experimenting with joining conductors quickly and easily in the field. Two types of tools have been developed, one for light wires up to 0.048-in. dia. and the other for wires up to 0.144 in. in dia.

Application study, by General Electric Co., Ltd., Koldweld, and their licensees, is continually adding to the ever widening field of cold pressure welding applications, an effective testimony to the versatility of the new process.

Fig. 7—Cold pressure welding has found many applications for joining electrical conductors. Some typical welds are shown here.



Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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Mechanical Finishing of Metals—
for Decorative Purposes

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Consumer products must have eye appeal to sell, and this eye appeal must be inherent not only in the mechanical design of the product but also in its surface finish. Some methods of producing attractive surface finishes on metals have been covered in previous Manuals; this one deals exclusively with mechanical processes—polishing, buffing, brushing, blasting, and tumbling and burnishing. These "unit operations" of mechanical finishing are evaluated as to advantages, limitations and control of process variables. In addition, specific finishing procedures are outlined for each of the major groups of alloys. This comprehensive Manual should provide the engineer and designer with a sound basis for intelligent selection of mechanical finishing procedures for his metal products.

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The Selection Problem

The life of a product designer would be a lot simpler if *performance* were his only worry. Unfortunately, the human beings who must buy his brain-child want a little more. The designer need only imagine himself as consumer to be aware of the great economic significance attached to attractive surface *appearance* of metal products.

Pleasing metal surfaces can be obtained in a number of ways. Some of these methods have been discussed in previous "Materials & Methods Manuals," including Organic Finishes for Metals (No. 32), Electroplated Coatings (No. 38), and Coloring of Metals (No. 50). The present Manual is intended to round out the decorative finishing picture by concentrating exclusively on *mechanical* methods used to produce desirable metal surfaces.

Mechanical finishing, of course, is a broad term. But this article will be concerned only with processes used specifically to produce certain characteristic surface finishes. Thus, sand blasting to remove scale, and grinding to remove burrs will not be covered, as they are essentially "cleaning" processes. And honing and superfinishing to produce favorable wear surfaces will be omitted because their object is essentially utilitarian.

It should also be emphasized that this Manual is not intended as a detailed instruction booklet for finishing superintendents, let alone individual operations supervisors. Rather, it has been planned to assist those engineers and executives who are concerned with materials problems in product design. Surface appearance is only one of many decisions which must be made, but it is probably one of the most important dollar-wise.

With these purposes and limitations in mind, the content of this Manual has been organized as follows: (1) A brief outline of the different types of finishes which can be obtained on metals, the methods used to produce them, and the selection factors which should be considered. (2) Descriptions of the various "unit operations" of mechanical finishing, including advantages, limitations, control of variables, and details on the essential process ingredients. (3) Further details on mechanical finishing procedures as applied to specific groups of alloys.

Considering the wide variety of mechanical finishes, it is perhaps a little risky to talk in terms of "standard" finishes. However, there are eight different types which are generally recognized, and these are listed below in order of descending brilliance:

1. Mirror—no surface defects visible.
2. Bright Buffed—no surface defects, but less brilliant.
3. Bright Satin—no surface defects visible, but finishing lines visible.
4. Regular Satin—no surface defects visible, heavier lines.
5. Satin—some slight defects, heavy lines.
6. Dull Satin—very heavy lines.
7. Bright Matte—etched or frosted finish with some luster but no lines visible.
8. Dull Matte—dead etched or frosted finish with no luster and no lines visible.

All of these finishes can be produced by polishing, buffing, brushing, tumbling or blasting—alone or in sequence with one another. In addition, attractive scratched and dimpled surfaces can be produced by somewhat more specialized processes, such as engine turning, engraving, embossing, hammering and shot blasting. Because of their relatively limited application, however, these latter methods will be covered only briefly in this Manual.

Selection of the proper finish is largely an economic problem. Obviously, low unit cost can be achieved only by choosing the cheapest finish that will serve the end purpose. Generally speaking, the more or less standard finishes listed above are in order of decreasing cost of production. Therefore, disregarding such factors as consumer taste and maintenance cost, matte finishes are to be preferred to satin finishes, and satin finishes are to be preferred to mirror surfaces.

Unfortunately, complicating factors cannot be ignored. Smooth, bright surfaces look cleaner and, in fact, can be kept cleaner because there are no ridges to catch dirt. However, oil and grease are much more readily visible on mirror surfaces than on lower finishes; this difficulty has led to use of satin finishes on much kitchen and cafeteria equipment. High mirror finishes are extremely popular on consumer items, but there are many cases where lower finishes would suffice provided that the items were not forced to compete for attention with other highly finished parts. One possibility which should always be considered, especially on large flat surfaces, is a combination of finishes having contrasting grain or brightness.

Once the finish has been chosen, there remains the question of what method to use. There is always the temptation to utilize existing equipment and supplies and, especially, for small runs, this is generally the most economical course. For long runs, however, the possibility of achieving lower unit costs by newer methods should always be investigated. Tremendous savings can often be realized by installing tumbling equipment or automatic buffing machinery.

Sometimes the most economical finishing sequence is one involving two or three different methods of finishing. Unless detailed cost figures are available to the engineer as a result of long and varied experience, such combinations are usually discovered only through experimentation.

Finally, the finishing processes selected must be compatible with the design and fabrication of the part. Sharp angles are difficult to polish but are often handled satisfactorily in a tumbling barrel; on the other hand, large flat surfaces are generally more satisfactory polished and buffed than tumbled and burnished. Polishing operations preceding drawing must allow for subsequent coarsening of the surface, and greasy buffing compounds must be removable by the cleaning system in use. It is clear that selection of both finish and method are closely tied up with the many other decisions which comprise product design.

Mechanical Finishing Processes

It would be impractical to discuss all possible finishing procedures in the space of this article. But there are certain basic operations involved in practically all commonly-used sequences. These are polishing, buffing, brushing, tumbling and blasting. A knowledge of these basic processes is prerequisite to an understanding of the possibilities and limitations of decorative metal finishing.

Polishing

Just where finish grinding stops and polishing begins is sometimes more a matter of opinion than of technical distinction. Perhaps the best way to distinguish between them is to realize that the purpose of finish grinding is not so much to produce a specified appearance as it is to remove scale, burrs and gross imperfections. The object of polishing, on the other hand, is to produce surfaces having definite appearance characteristics. Or, more specifically, polishing is sometimes defined as "the use of flexible wheels or belts, coated with adhesive and abrasive grain, to produce desirable surfaces on metals where dimensional requirements are not exacting."

Although metal polishing is much older than recorded history, it is still more an

"art" than a science. The sequence of operations required to produce a surface of specified characteristics on a given metal varies greatly in different polishing rooms, and often varies to some extent among operators in a single polishing room. However, as automatic machinery grows in popularity, it is only natural to expect that metal polishing will eventually be standardized, just as heat treating and electroplating have been in recent years. Even now, despite the complexity of the factors governing polishing, most types of finishes are commercially reproducible within rather close limits, assuming normal manufacturing care.

Essentially, polishing involves wearing down the ridges on a metal surface by abrasive particles of progressively smaller size which produce a surface of progressively finer scratches. The amount of metal removed is small and can be reduced still further if suitable lubrication is provided.

The most economical polished finish to produce is the roughest acceptable one. Some materials are more difficult to polish than others, but generally it can be said that mechanical design, not choice of materials, governs cost. Parts with small radii, deep grooves and undercuts are costlier to polish than parts with sweeping curves, large radii and no grooves or undercuts.

Abrasives—One of the most important factors in polishing is the type and size of abrasive, whether used on wheel or belt. An abrasive for metal must meet several qualifications. These include hardness; toughness; uniformity in chemical composition, crystal structure and grain size; and high capillarity to aid wetting with glue. Furthermore, its shape must be controlled to retain a cutting edge under specified conditions.

Abrasives used on metals include fused and unfused aluminum oxide, silicon carbide, emery, pumice, rouge, chromium oxide, quartz, tripoli, lime, diatomaceous earth and chalk. Some of these have rather weak cutting action and are used only in buffing operations.

At one time, natural emery was used almost exclusively for metal polishing. However, because of its relatively slow cutting rate on hard metals, natural emery has been almost entirely replaced by manufactured abrasives. Nevertheless, some polishers still prefer emery over manufactured abrasives for nonferrous metals.

Alumina is by far the most important abrasive used today. It is available in standard sizes ranging from 4 to 240 mesh screened, flour sizes 280 to 600, and additional unclassified flours. The abrasive is produced in two principal forms to satisfy different finishing requirements. Sharp-edged, angular grains are used for light metals, such as bronze and aluminum, while rough, blocky grains are used for steel and other materials having high tensile strength. Both types of grains are also produced in somewhat roughened grades suitable for production work where more rugged service is required.

Polishing Wheels—Polishing operations are still commonly handled on "set-up" wheels which have been abrasive-coated by the fabricator. The trend in recent years, however, has been toward the use of factory-coated wheels and belts which offer greater uniformity.

Despite innovations, the set-up polishing wheel remains the old stand-by in metal finishing work. (Courtesy Norton Co.)

Polishing wheels, whether set up by supplier or fabricator, generally consist of cotton fabric, wool felt, sheepskin leather, walrus leather, bullneck leather, canvas or leather-covered wood. What is probably the most commonly used wheel is made up of full disk or sewed pieced buff sections glued or cemented together to form a wheel of desired thickness. Such wheels are used for general-purpose polishing of ferrous and nonferrous metals.

Canvas wheels of varying construction and density are used for "roughing out" iron and steel and both ferrous and nonferrous castings. Sheepskin wheels, also available in a wide range of densities, are preferred for fine grit work where flexibility is needed. Despite fairly high cost, walrus hide is used in fine finishing of firearms, cutlery, silverware and parts of brass and high-grade carbon steel. This material is advantageous for grease wheel polishing because it can be cleansed of grease and oil merely by soaking in gasoline. Wood covered with oak-tanned back leather is used to polish flat work, such as cabinet hardware and cutlery, as well as sewing machine parts and hand tools.

Felt wheels are used mainly for dry fine finishing and grease wheel operations. These wheels can be obtained in densities ranging from "flint hard" to "extra soft." In order of decreasing density, such wheels are suitable for steel forgings and hard alloys, steel castings, high polish before plating, cast iron and stainless steel, copper and aluminum alloys, and zinc die castings. In addition, felt is used in the form of "bobs"—small, irregular-shaped pieces useful in polishing internal and irregular-shaped surfaces.

Bullneck leather has an open grain which

This stainless steel part is being polished by means of an endless abrasive belt and a pressure pad. (Courtesy Armco Steel Corp.)

provides good adherence for glue and grain, so it is often used for heavy polishing on cast iron and steel. In larger sizes, however, it can be replaced by a leather compress wheel which, in the long run, is less expensive.

The compress wheel is a good general-purpose wheel and is especially suitable where it is necessary to form the face to suit irregular shapes on the work. It is usually made in canvas or leather, and is available in a range of densities. The canvas wheel is most popular, and is used for roughing, dry polishing and oil and grease work, especially on cutlery and small tools. The walrus hide wheel is used for fine finishing and high color.

Selection of the proper type of wheel is largely dependent on the degree of resilience required. Diameter and thickness, of course, are governed by the size and shape of the article to be polished.

Abrasive Binders—Until recently, hide glue was almost universally used as the binder in polishing wheels, but now it has been replaced to a certain extent by cold cements. A cement-bonded wheel is easier to set up as no heat is required, and cold cements are generally preferred for 150 mesh and coarser grits because of the fast cut possible. A good grade of glue or cement is essential for polishing wheels, and economies cannot be realized through purchase of cheap binder.

Abrasive Belts and Strips—The common name for abrasive belts and strips is "sandpaper," but this is something of an oversimplification. Abrasives used on belts and strips are flint, emery, silicon carbide and alumina, with the last by far the most important. Backings used in metal polishing are cloth and combinations of cloth and paper or cloth and fiber, bound with glue, synthetic resin cements, or both. The abrasive-coated backing is used either as strips applied to the face of special contact wheels or as endless belts running over contact wheels or curved hand-blocks.

An important consideration in selecting endless abrasive belts is the type of contact wheel to be used. Since the work is held against this wheel, it is clear that those factors discussed in relation to wheel selection can also be applied here. Canvas or leather compress wheels of varying densities are often used, and pleated-construction wheels are common for light contour work.

Lubricants—Lubricants are important in polishing, not only to prolong the life of the wheel or belt, but principally to control the degree of finish obtained. A lubricated wheel produces a less shiny surface with fewer microscopic burrs. Lubricants are not generally used on wheels coarser than 150 grit. Careful selection of lubricants can reduce the number of different grit sizes required in a polishing sequence.

Lubricants ordinarily used are a mixture of tallow and stearic acid applied in stick

form, or a mixture of kerosene and machine oil applied with a swab. Buffing compounds are sometimes used where minimum lubrication is desired. Saponifiable lubricants are desirable for ease of removal.

Greaseless Polishing—One of the most significant advances in metal polishing has been the development of greaseless polishing compounds. These compounds are composed of abrasive, glue in the jelly state, and various accelerators which set the glue on contact with air. Applied to a wheel, the compound dries in a few seconds, forming a flexible abrasive head. Since these compounds can be used on wheels, buffs or bobs of practically any size, they are especially valuable in polishing hard-to-reach surfaces.

With coarse-grained compounds on relatively hard wheels, greaseless polishing produces results similar to those of set-up wheels. But generally the wheels or buffs used are much softer than the conventional set-up wheel. Fine grain sizes on soft wheels impart a satin or matte finish similar to a tampico finish but with less metal removal and better color. The greaseless method is widely used for all-over finish, especially where the surface does not require much roughing. Decorative effects can be produced by color buffing first, then toning with greaseless polishing those areas which appear in the openings of a design mask. Whereas set-up wheel and belt polishing are used almost entirely as preliminary finishing operations, it is clear that greaseless polishing can be used to produce desirable end finishes.

Equipment—Both wheel and belt polishing require lathes with sufficient power to maintain spindle speed under load without vibration. This speed, of course, should vary according to the surface speed desired for specific operations. Exhausts must be supplied on the lathes. For belt polishing, a back stand must also be provided. These back stands are equipped to maintain constant tension on the belt to eliminate slipping and to assure proper tracking. A variety of portable and hand equipment is also used in polishing, especially on small parts.

Sequence and Technique—Experience has proved that it is preferable to "rough out" with as fine a grit as economically possible so that succeeding grits are not overworked in removing coarse or roughing scratches. The choice of finishing grit size depends on the operations scheduled to follow immediately after polishing. (Polishing sequences to be followed by drawing operations should be extended to compensate for the "opening up" of the surface accompanying drawing.) Intermediate grain sizes should be spaced at 40- to 60-mesh intervals for most economical operation. For instance, a material requiring a No. 100 roughing grit cannot be economically polished to the same finish in the same number of steps as a material requiring only a No. 150 roughing grit. Wheel speeds are generally specified in terms of surface feet per minute, meaning the speed at which the outer edge turns. Most economical speed for set-up wheels seems to be about 7500 sfpm. Higher speeds, especially on thin sheet, may discolor or distort the metal; and on low-melting metals, it is important that surface fusion be avoided. In most cases, optimum speeds can only be determined by experiment.

There are innumerable "do's and don'ts" for metal polishers, but these need not be discussed here. The great number of variables involved, however, make it essential that the metal polisher be highly skilled and experienced.

Sand Bobbing—Sand polishing or bobbing is the name given to a type of finishing performed without a coated wheel or belt. In this process, a mixture of pumice and water or oil is applied between the wheel and the work. Felt or walrus hide wheels are commonly used. The method is used to remove scratches and pits from metal—usually sterling or other precious metals. It produces a fine-lined or scratched finish similar to that left by a polishing wheel.

Buffing

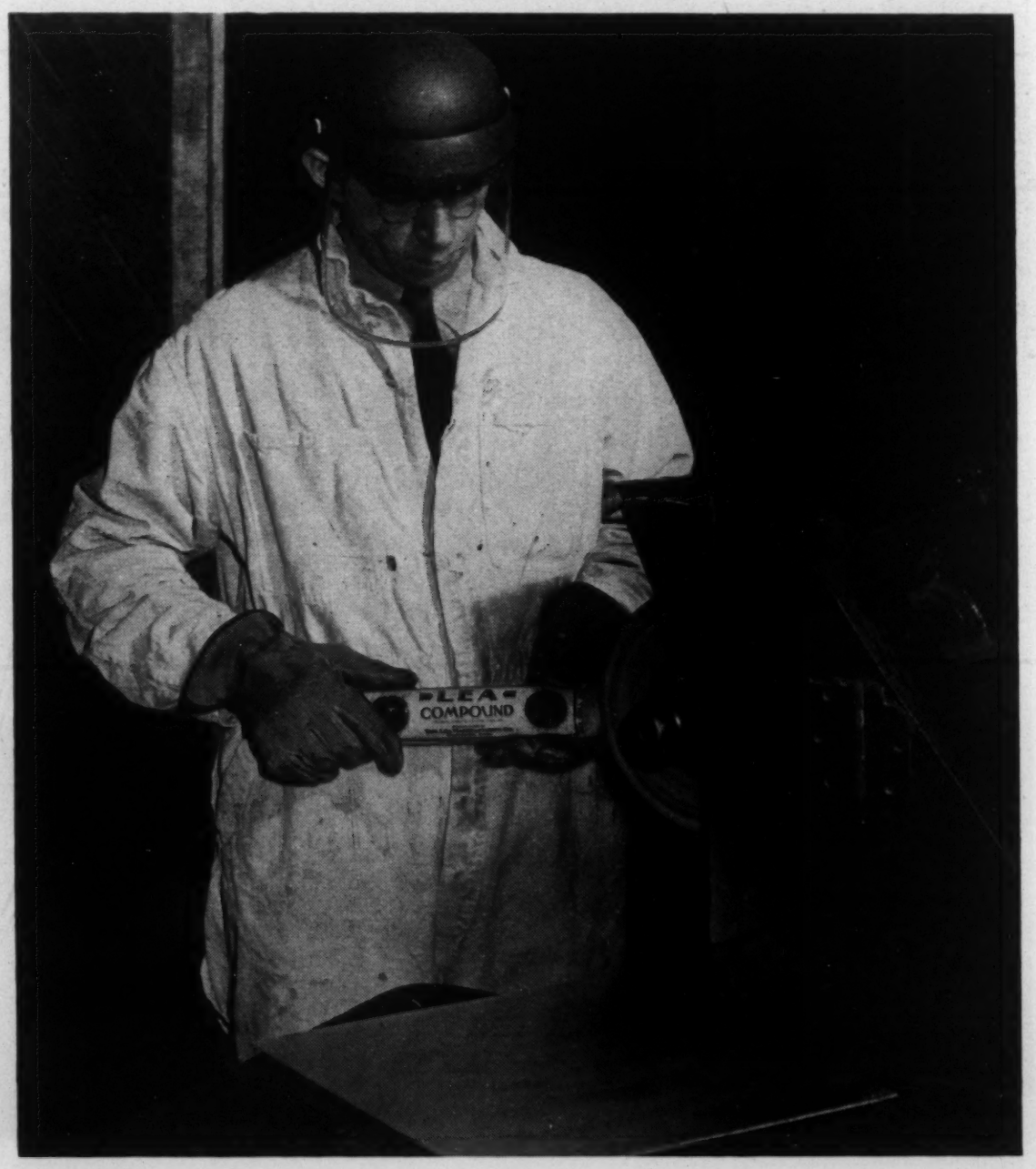
Buffing almost always follows a polishing operation, and it often follows other finishing processes, such as brushing or tumbling, where higher luster is desired. Essentially, the buffing process amounts to a further surface refinement by means of finer abrasives and more flexible wheels than are used in polishing.

A lustrous surface can be produced by buffing before the surface has been polished down, but grain scratches in the work remain. Preceded by proper polishing methods, however, buffing can produce mirror-like surfaces. In general, hard materials must be polished to a finer finish before buffing than must soft materials.

The buffing process is performed by means of a revolving cloth "buff" charged with buffing compound. Buffing is generally considered to consist of two separate steps. The cutting down operation utilizes a sharp or fast-cutting compound to smooth the surface. The second step, known as coloring, uses a milder compound designed primarily to heighten the luster. Often, these two functions are performed simultaneously by means of a cut-and-color compound with intermediate cutting action. This short cut, however, does not bring out the highest possible color.

Buffing Compounds—Buffing compounds consist of abrasives held in a binder-carrier

A greaseless polishing compound will be used to produce a fine finish on this magnesium alloy sheet. (Courtesy Dow Chemical Co.)



which is a mixture of greases. The amount, type and size of abrasive depend upon the material being polished and the finish desired.

One of the oldest and most widely used buffing abrasives is tripoli, actually amorphous silica. It is particularly useful on nonferrous metals, and the amount of binder is varied according to the type of service desired. For instance, a greasy grade is used on automatic buffing machines for aluminum castings and stampings where fast cut is wanted. At the other extreme, a dry grade is used for light work on aluminum or brass stampings and zinc die castings or for coloring copper-plated parts. An intermediate mixture can be used as a cut-and-color compound.

An abrasive similar to tripoli in that it is primarily amorphous silica is sometimes called white coloring compound. Finer grain and freedom from iron and clay make this material better for coloring. It also is used on nonferrous metals. A cut-and-color compound often used consists of a mixture of white coloring compound and tripoli. Hard, crystalline silicas can also be used but they are poor for hard metals as the grains do not break down to provide fresh cutting edges. This form of silica also has low grease absorption.

Vienna lime, consisting of unslaked calcium and magnesium oxides, was originally developed for nickel-plated work but is also used extensively on copper-plated work where a clear, high luster is desired. Greasy grades are used on jobs such as large plumbing fixtures, furniture tubing, stove parts and auto bumpers. Drier compounds are used to color small nickel-plated objects. Added color can sometimes be obtained by mixing Vienna lime with a small amount of red rouge.

Technically, rouge is just another name for iron oxide. Iron powder may be red, yellow, brown, purple or black, according to its state of oxidation. A soft, fine red rouge, bound with a little grease, produces high luster on metals such as gold, silver, sterling, platinum and brass. A somewhat coarser purple variety, called crocus, has been widely used in the past to bring up mirror finishes on brass, aluminum, copper, lead, tin plate and soft metals. A cut-and-color compound, known as pink rouge, is actually a mixture of red rouge and alumina.

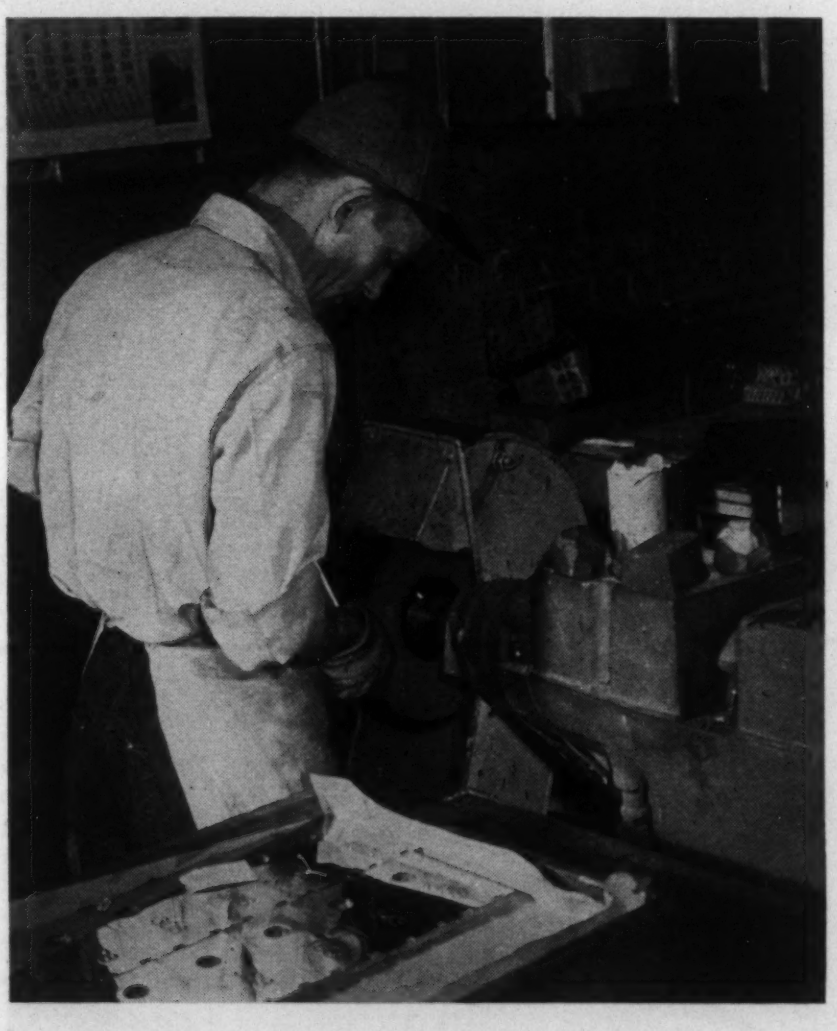
Some abrasives called rouge actually contain no iron oxide at all. One example is white rouge, which is made from pure alumina. Originally developed to color chromium plate, it is now used extensively on stainless steel.

Buffing Compound Binders—Many different substances are used as binders for buffing compounds. Probably the most common is beef or mutton tallow, which is completely saponifiable and easily emulsifiable. Stearic acid also saponifies completely and is combined with tallow in various proportions according to the melting point desired. Additives such as petroleum jelly and rosin are sometimes used to increase "tack" and control back transfer of compound from the work. They are useful if present with emulsifiers and saponifiers so that the work can be readily cleaned.

There are countless other binders used. Most of them are less expensive than tallow, stearic acid or petroleum jelly, and are sometimes mixed with them to cheapen the compound. However, the additional cleaning problems posed by these cheap binders generally offset any momentary economies.

In addition, the buffing operation can also be accomplished by means of greaseless compounds. The characteristics of these compounds have been described earlier, but

Safety deposit box doors of stainless steel are buffed for high luster. (Courtesy Armco Steel Corp.)



Buffing brings up a high luster on this aluminum casting. (Courtesy Aluminum Co. of America.)

it should be noted here that their grit size range extends from 80 to 450, thus virtually encompassing both polishing and buffing operations.

Liquid Buffing Compounds—An important step in the modernization of finishing procedures has been the development of liquid buffing compounds. These compounds actually consist of abrasives suspended in water-grease emulsions which can be sprayed onto the buff as required, the water quickly evaporating. They are available in types and grades suitable for all working surfaces.

Such compounds offer a number of advantages. They save time on the part of the metal polisher. Regulating the spray so that only the required amount is applied can save up to 50% in weight of compound, and stub waste is eliminated. At the same time, buff life is increased when the amount of buffing head is carefully controlled.

The liquid spray method is particularly valuable in automatic buffing operations, since the compound can be brushed evenly over the buff surface as it is applied. This technique is being used on auto body moldings, hub caps, bumpers, reflectors and other mass-produced large-area parts.

Buffs—There are three general types of buffs—full disk, pieced and bias. In the full disk type, each ply is a one-piece cloth disk with every two layers slightly rotated to equalize wear and insure balanced weight distribution. Standard thickness is 20-ply, or about ¼ in. When these buffs are made with just one row of sewing around the arbor hole, they are called loose buffs. They can be sewed in any desired pattern, *e.g.*, spiral, square, concentric, etc., to provide added stiffness.

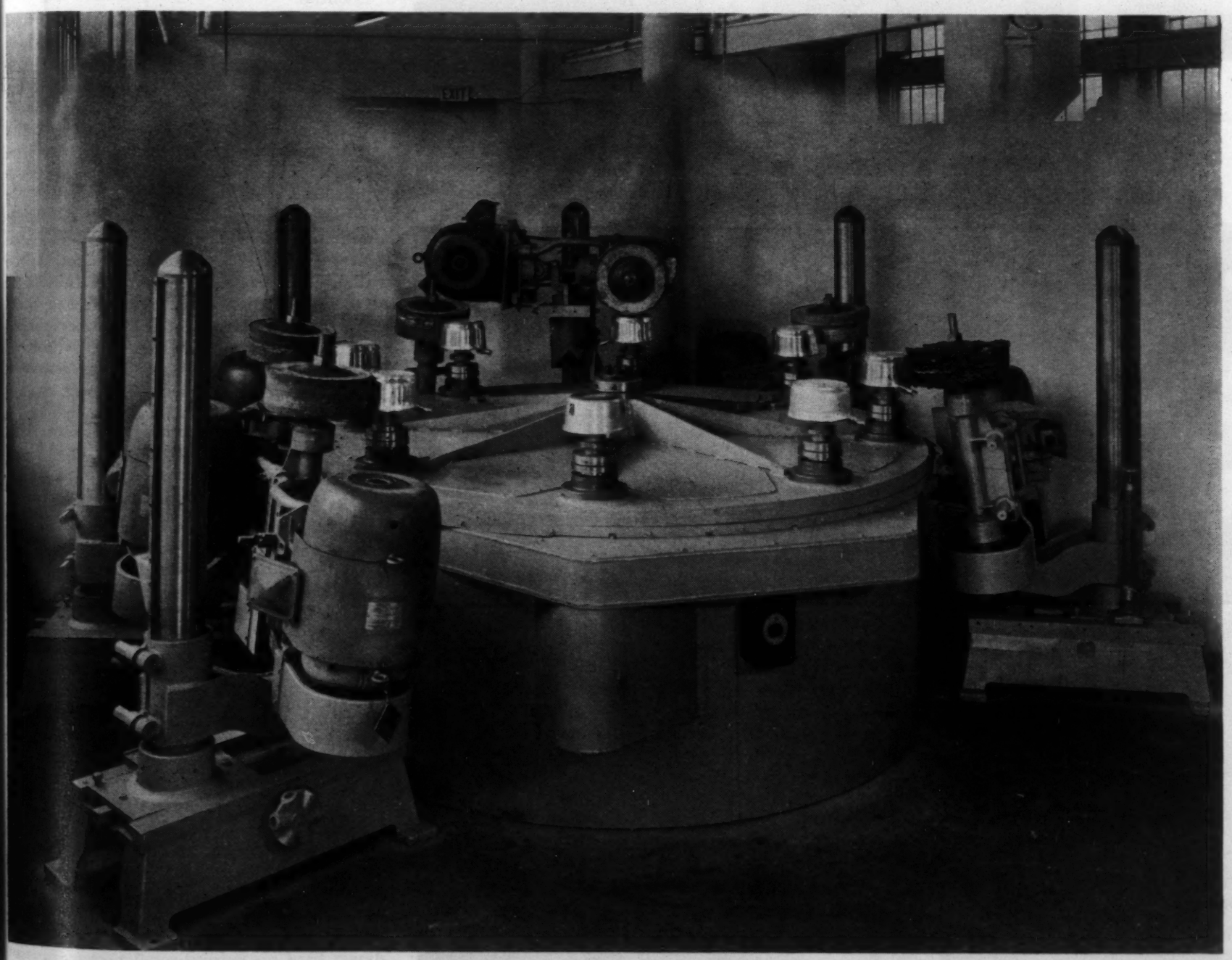
The types of service intended for the buff determines proper cloth weight and cloth count. Cloth count is measured by counting the number of threads per inch in both directions. Thus, a count of 86/93 means the cloth has 86 threads per in. in one direction and 93 in the other.

Full disk cloth is available in a wide range of cloth count. Cloth counting 86/93 is used where fast cut with long wear is necessary, as in automatic or semi-automatic operations on steel, nickel plate or chromium plate. Cloth counting about 80/92 is used for fast cut on fine work such as jewelry, sterling, and plated flat and hollow ware. It is also used to cut aluminum and to color chromium plate.

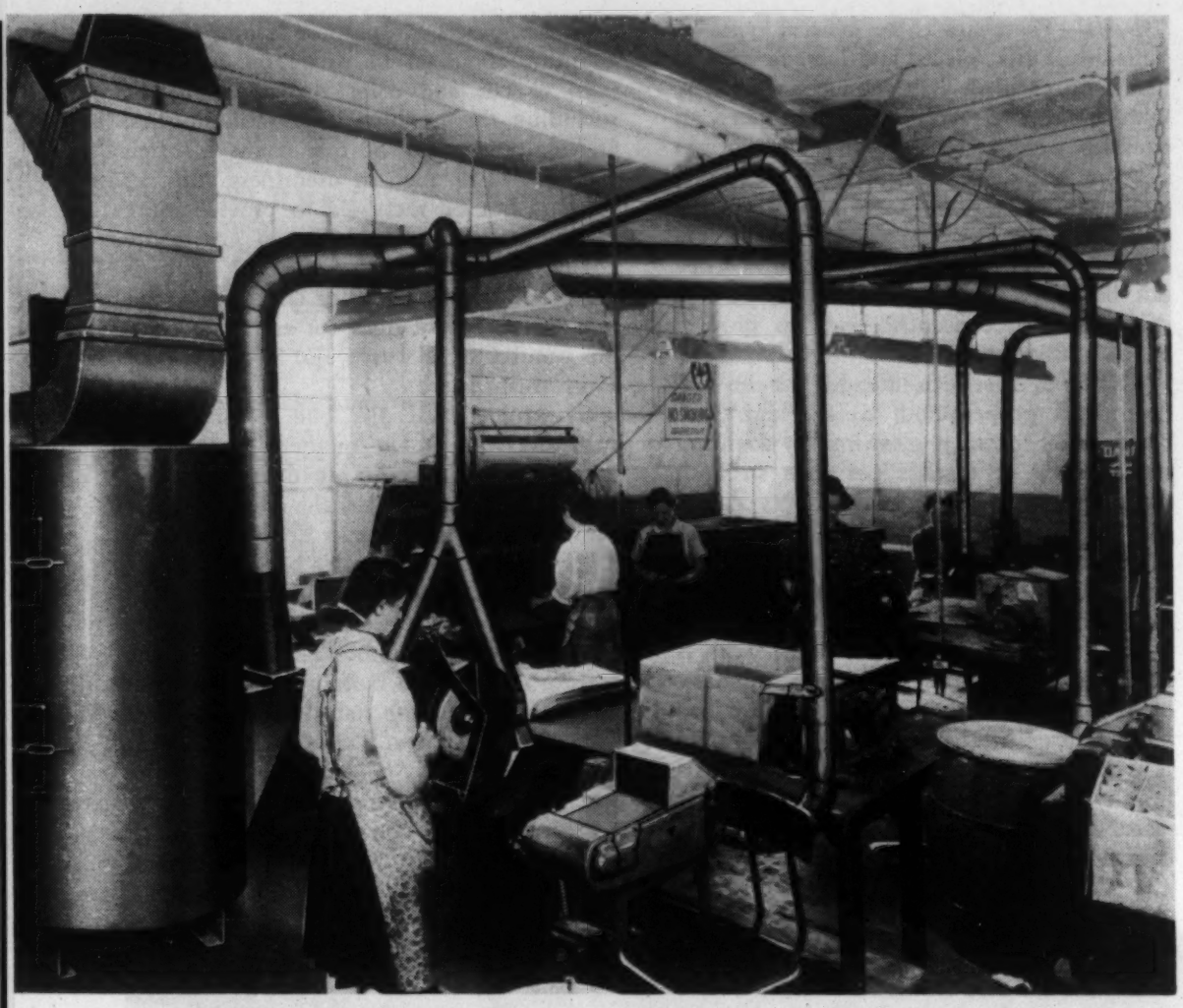
A more general-purpose cloth is one counting about 64/68 or 64/64. It can be used to cut and color the softer metals, including the production of satin finishes. In addition, cloth of this count is often modified to broaden its usefulness; thus, its stiffness can be increased to provide more cutting action or decreased to give more color. The softest standard buff cloth is 48/48 or 44/48, used for silver and other fine metals where light cut and high color are wanted. This weave also is suitable for satin finishing.

The folded full disk buff, consisting of full disks folded in quarters or eighths, assembled radially and sewed at the center, provides fast cut and has the advantage of a broken face which breaks up buffing lines.

Pieced buffs are so called because the buff section is composed of irregular-shaped cloth strips, laminated between two outside covers of full disk cloth. Other factors equal, the cutting rate of such buffs is determined not by the full disk cloth count but by the types of sewing and the spacing of the sewing in the pieced sections beneath. The closer the stitching, the stiffer the buff and the faster the cut. Common types of sewing in pieced buffs are spiral, sun ray, curved tangent,



Automatic buffing machinery can lower the unit finishing cost on mass-produced items. (Courtesy Murray-Way Corp.)



This small mechanical finishing department is equipped with an extensive dust collection system, especially important in magnesium fabrication. (Courtesy Newcomb-Detroit Co.)

The satin finish applied by scratch brushing improves not only the appearance but also the heating efficiency of this aluminum cooking utensil. (Courtesy Aluminum Co. of America.)

square, parallel and concentric. Spiral-sewed buffs are among the oldest and most widely used, with ⅜-in. spacing most popular. Bleached, unbleached and colored cloth is used in pieced buffs. Buffs containing colored cloth are cheaper but have shorter wear life.

The bias-type buff is particularly advantageous for heavy duty applications. This buff consists of cloth strips cut on the bias and wound around a center to which it is attached. The gathering of the material forms puckers or pleats, which increase stiffness. The puckers provide a wide face width per section, and the broken face crosses buffing lines, thereby reducing directionality in finish. Some proprietary types feature holes and channels for ventilation; these keep the buff cooler under the high pressures used in automatic buffing.

A buff of entirely different construction than the conventional types is the string brush, designed for maximum flexibility. Such wheels are built like a circular brush, but with string, wick or cord radiating from the hub instead of wire or bristle. The string wheel is the softer and is used mainly for coloring. The cord wheel is suitable for cutting operations where the contour is such that maximum flexibility is essential.

Technique and Equipment—Speeds used in buffing vary from 3,000 to 15,000 sfpm. Slower speeds are used with flannel buffs and with some greaseless compounds. For most operations, a speed of 10,000 sfpm. is about right. Higher speeds tend to throw compound and fabric frays rapidly. Operator skill is as important in buffing as it is in polishing.

Various types of automatic and semi-automatic machines and variable- or constant-speed lathes are used in buffing operations. Since buffs vary in size from 2 to 20 in. in dia. or more, variable speed lathes are to be preferred so that proper surface speed can be maintained. For wheels of equal diameter and face, more power is needed in buffing than in polishing. A good exhaust system is also necessary.

Brushing

As a decorative finishing process for metals, brushing is probably less important today than in former years. Nevertheless, a number of useful finishes, both preliminary and final, can be produced by wire and nonmetallic fiber brushes.

Used without polishing or buffing compounds, brushing involves primarily a blending or kneading action rather than metal removal. The result is a surface characterized by long parallel scratches and a luster somewhat duller than that obtained from polishing and buffing operations. Even with fairly soft nonmetallic bristles and fine buffing compounds, brushed finishes do not compare with buffed finishes where high luster is desired.

Tampico brushing, once widely used, is gradually becoming obsolete. This operation utilizes special nonmetallic brushes and a cake abrasive. It removes metal in small amounts but produces a matte or egg shell finish without pronounced parallel lines. A

tampico wheel, with emery paste, gives a finish similar to that obtained with wire wheels.

Another application which is becoming less widespread is satin finishing by means of fine wire brushes. Most satin finishes are now produced by means of greaseless polishing compounds on soft wheels, since this procedure reduces cleaning problems.

Greaseless polishing compounds are used frequently with brushes. However, the actual mechanism is more like buffing than polishing, since the compound is applied loosely rather than as fixed abrasive. Generally such operations are performed in conjunction with regular polishing and buffing sequences. For instance, the fine polishing operations preceding buffing can sometimes be handled more economically by brushing with greaseless compounds than by grease wheel polishing.

Polishing with brushes offers a number of special advantages. Most important is the high degree of flexibility which allows the brushes to conform to slight irregularities and, therefore, act uniformly over the entire surface. This flexibility reduces the danger of tracking or scratching by "wild grains," which sometimes occurs in polishing wheels. With buffing compounds, brushes appear to have less tendency to develop "drag lines" in the surface than do cloth buffs. Furthermore, brushed surfaces are believed by some to offer better surfaces for plating than surfaces produced by regular polishing and buffing.

Brush Selection—Both wire and nonmetallic brushes are used to finish metals. Wire composition varies according to the material being brushed, with harder materials calling for stronger wires, and vice versa. In general, wire brushes are used for coarser types of finishes, as they are capable of greater metal removal when used with polishing compounds. However, brushes containing extremely fine wires can be used to produce satin finishes, as mentioned above. Ordinary and treated tampico brushes can be used with proper compounds to produce a wide variety of finishes, coarse and medium in texture. Finer finishes can be obtained with cord brushes which are cooler acting and more flexible than most buffing tools.

Regardless of the type of brush used, there are certain variables which should be considered. These are fiber size, trim length, density of brush-fill, quality of fill material, outside diameter, and surface speed.

For instance, brushing action can be speeded up by increasing the diameter of the wire or fiber. Longest brush life and best surface finishes, however, are obtained by using the smallest diameter wire which will do the job with normal operating pressures. Wire sizes vary from 0.003 to 0.010 in. in dia. Generally, high-quality wire or fiber is always the most economical choice in the long run.

Increasing trim length reduces the density of fill at the working face so that the brush becomes more flexible and slower acting, but capable of greater depth of penetration. A satin finish can be approached in this way. However, finer finishes on hard metals are obtained by decreasing trim length, and cutting of softer and more ductile materials is usually improved. Trim length is generally regulated in connection with brush-fill density, thus making possible wide variations in flexibility.

Within the limitations of the particular job and equipment, the largest diameter brush is usually the most efficient. Size should be decreased only as required by lack of clearance or for work on small parts.

Results can be hurried by increasing brush surface speed, although the most practical speeds are in the range between 5000 and 10,000 sfpm. Running the brush at low speed increases penetration but often does not give satisfactory results. Surface speeds of 2900 and even lower can be effective with a wire brush having short trim and extremely dense fill, but such speeds are ineffective for nonmetallic brushes used with compounds. For most efficient operation, brush surface speed should be held constant throughout the life of the brush by means of variable speed equipment.

Tumbling, Burnishing

A complete description of the tumbling process would have to cover a lot of ground. But this discussion will be limited to its use where surface finish, not deburring, is the primary consideration.

Even with this limitation, however, the number of different procedures involved in common tumbling processes is likely to cause some confusion. To avoid this, tumbling processes for finishing will be classified here in two ways. First, there are two general methods—dry and wet. Second, there are two general purposes—abrasive tumbling and lustering. The abrasive tumbling procedures are sometimes known as cutting down and smoothing, and lustering is also known as burnishing. Both purposes can be accomplished by either the dry or wet processes.

Like all other finishing processes covered in this section, tumbling is often used in connection with other methods. However, recent experience has shown that a great variety of parts can be completely finished by tumbling alone with significant savings, sometimes more than 50% compared to buffing. The low cost is made possible by lack of need for skilled labor or constant attention, ability to use the same equipment regardless of design changes, and the less time per unit usually required. In addition to economy, the main advantage is uniformity of finish. Finishes produced by tumbling range from dull matte to a luster equivalent to that obtained from buffing.

Parts ranging in weight from a fraction of an ounce up to 75 lb. have been successfully tumbled, but usually intricate parts heavier than 4 to 5 oz. or compact objects over 1 lb. cannot be polished or burnished economically in a free tumbling operation.

Large parts, hollow shapes or parts with heavy sections which would cause them to fall in the same position are selectively affected in normal tumbling. Such parts can be racked or fixed in position in the tumbling barrel so that carrier and compound pass through and around them, permitting the mixture to reach all areas of the parts. Or, the parts can be tumbled in specially designed compartments which restrict their motion to a definite direction. In either case, barrel rotation is reversed periodically to provide uniform action. The latter method is used for long, narrow parts, such as blades, umbrella ribs, knitting needles and cutlery, which would otherwise bend.

A part having sharp corners or edges, large flat areas or poor symmetry and balance is generally hard to process, and soft materials are more difficult than hard ones. The ideal part is small, curved, with no deep recesses and with mass evenly distributed. Probably the chief disadvantage of tumbling compared to competing methods is that usually specific corners and edges cannot be left unbroken or surfaces untouched.

Tumbling is sometimes called barrel finishing, since a barrel is invariably used to produce the tumbling action. Best results have been obtained with an octagonal, horizontal cylindrical barrel, 18 to 36 in. in dia., with compartments at least 18 in. long. Tilting barrels, which produce less churning action, are still widely used. However, they seem to be of advantage only for certain special applications, such as wire products which tend to become tangled if tumbled too violently. Barrel construction depends upon the severity of service intended. In dry processes, all-wood barrels or metal shells lined with wood or hard plastic are generally used. Wet tumbling and burnishing call for water-tight metal shells, lined with wood or hard plastic or coated with rubber or Neoprene. Unlined barrels are not suitable for high finishes. Barrels are rotated at speeds from 5 to 60 rpm. depending upon diameter and the particular results desired.

Operating supplies used in tumbling are compounds, carrier and media. Compounds may contain the abrasives used in cutting down or, as in the case of wet tumbling, they may be chemicals which assist the abrasive action. The grit size used should be such that abrasive will reach all recesses, fillets, angles and slots without becoming wedged in any part of the work. Carrier and media are dry solids, of irregular or specific shape, which have three functions: (1) to separate the parts to prevent impingement; (2) to provide pressure for the abrasive action; and (3) to provide complete envelopment and contact of all parts of the surface with the abrasive. The term media usually refers to material that contains its own abrasive or burnishing action.

In some cases, such as self-tumbling, it is possible to dispense with one or all of the operating supplies. Definite ratios of work, compound and carrier or media have been established for many different tumbling applications, but they are subject to considerable variation according to individual plant experience.

For most applications, the volume ratio of parts to tumbling media varies from 1:2 to 1:10. Special shapes or heavy parts may call for a ratio as high as 1:25. The total mass should fill at least 50 to 60% of the barrel. Speed of the barrel is determined by size and shape of the part, choice of media,

the metal involved and its strength, degree of finish desired and barrel size. Where parts and media are large and metal soft, for instance, speeds must be slower. Peripheral speeds of 100 to 200 fpm. are often suitable for cylinders 18 in. in dia. or larger, but speeds greater than 70 rpm. are excessive regardless of diameter.

To a certain extent, the choice between wet and dry tumbling processes is also subject to individual preference. Generally, with proper selection of operating supplies and speeds, comparable results can be obtained from both processes. Wet processes are much faster than dry processes. On the other hand, dry processes utilize lighter carriers; this is of advantage for fragile parts and also makes it possible to use lighter equipment and inexpensive loading, unloading and separating techniques. In practice, dry and wet processes are often combined.

Dry Tumbling and Burnishing—Proprietary compounds used for dry tumbling usually consist of: (1) abrasive powders; (2) abrasive creams; or (3) graded sawdust impregnated with a mixture of abrasives and various animal, vegetable and mineral oils. Commonly used abrasives are silica, alumina, pumice, limestone and rouge. Compounds are expendable, usually being discarded after each cycle or partially removed and the remainder freshened with new compound.

Carriers and media generally consist of vegetable ivory chips, granite chips, quartz chips, leather scraps, felt pieces, nut shells, macerated corn cobs, wooden shapes of hard maple or other hard woods, graded sawdust granules or plastic shapes. Sometimes metal shapes are used. These supplies last indefinitely, although chips and shapes require occasional cleaning to keep them in efficient operating condition.

Dry burnishing does not give true burnishing action, since abrasives are used. However, Vienna lime or rouge will produce surfaces equivalent to those obtained from buffing.

Wet Tumbling—Proprietary compounds for wet tumbling are chemical in nature and consist of various soaps, alkalies and mild acids which act as lubricants, buffers, wetting agents, sequestrants and corrosion preventives. They are used in combination with water or oils.

Media may or may not be used in wet tumbling. Occasionally, where the size and shape of the parts allows self-tumbling, the wet process is conducted with only the parts and a fine abrasive in the barrel. But most operations utilize media which may or may not be abrasive. Some media frequently used are alumina abrasive stones, granite chips, quartz chips, limestone chips, soft metal slugs, and hard wood shapes. Nonabrasive media are generally supplemented with abrasive creams of selected grit size.

No one tumbling medium can be most satisfactory and economical for all wet operations. Sometimes one type of medium is used for the cutting down operation and another for burnishing. For some production work, however, the added labor cost incurred in transferring the work from one medium to another is not warranted. In such cases, it is possible to conduct cutting down and burnishing operations with the same medium merely by altering the lubricating properties of the solution. With fine alumina, for instance, cutting down can be accomplished with the water level 0 to 4 in. below the work level, while surfaces similar to burnished surfaces can be obtained by raising the water level to 2 to 8 in. above the work. If small abrasive size and added solution are not enough to cushion the cutting action, buffers such as sawdust, flour and scrap leather must be added.

Toaster shell is polished by tampico brushing. (Courtesy Osborn Mfg. Co.)

Disposal of sludge and water are factors which must be considered in adopting a wet tumbling process. Special materials handling equipment for loading, separating and drying must also be considered, since the masses handled are usually much heavier than those encountered in the dry process.

Wet Burnishing—Wet burnishing is used both as the final step in a tumbling system to produce a high luster and as a single cycle for applying a high luster to soft cast alloys and parts which do not require previous processing by tumbling. For the most part, burnishing does not involve metal removal but rather cold working of the surface which closes the pores of the metal.

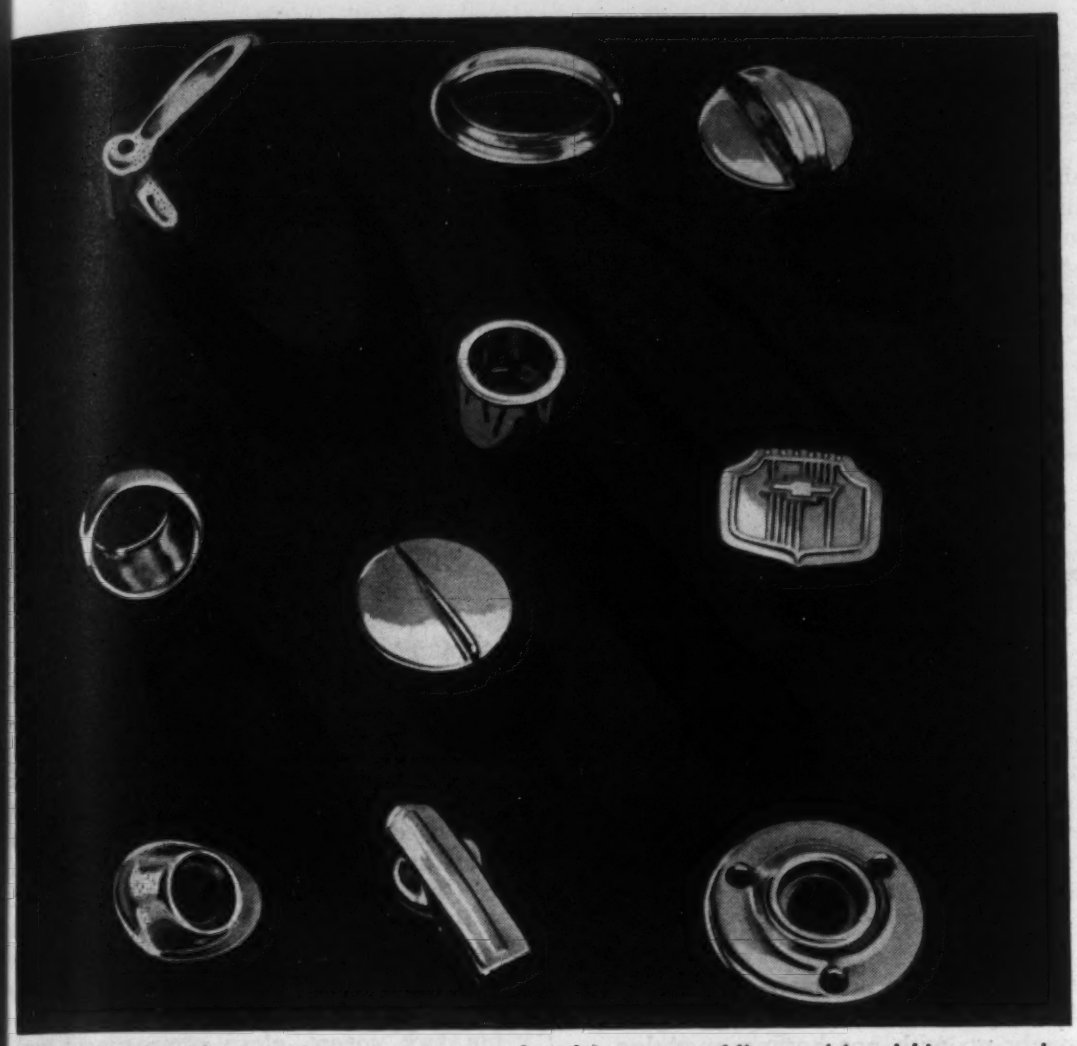
Two types of equipment are used in wet burnishing: (1) barrels which are charged with solution, media and parts, and emptied completely after each run; and (2) perforated barrels which rotate in a tank of burnishing solution.

Burnishing lubricants include such diversified substances as soap, soap bark, blackstrap molasses, stale beer, alkaline cleaners, cyanide and cream of tartar. Of these, soap is most used. Soaps can be neutral, acid or alkaline, depending on whether alkali base and fatty acid are present in exact chemical equivalents or not. A small percentage of free alkali or free fatty acid greatly influences the properties of soap solutions. Soaps vary in solubility, gelling power, ability to produce lather, ease in rinsing and viscosity; and these differences are important in burnishing. High-strength soaps provide optimum lubricating and burnishing action but should not be used where good rinsing is an important factor.

Hardened steel balls have been the most popular burnishing media for many years. Since balls will not burnish in corners or angles smaller than their own diameter, it has been necessary to develop a variety of special shapes, such as diagonals, cones, ball cones, fin balls, pins and oats. At least three other factors must be considered in selecting media size. First, size should be smaller for lighter metals and more fragile parts. Second, media size should be such as to prevent clogging of holes in the part. Third, for parts which cannot be separated magnetically, media size should be chosen to allow separation by screening. A recent development has been the use of die-cast zinc slugs as burnishing media, especially for the lighter metals.

Blasting

The use of sandblasting to clean castings and shotblasting to increase the fatigue



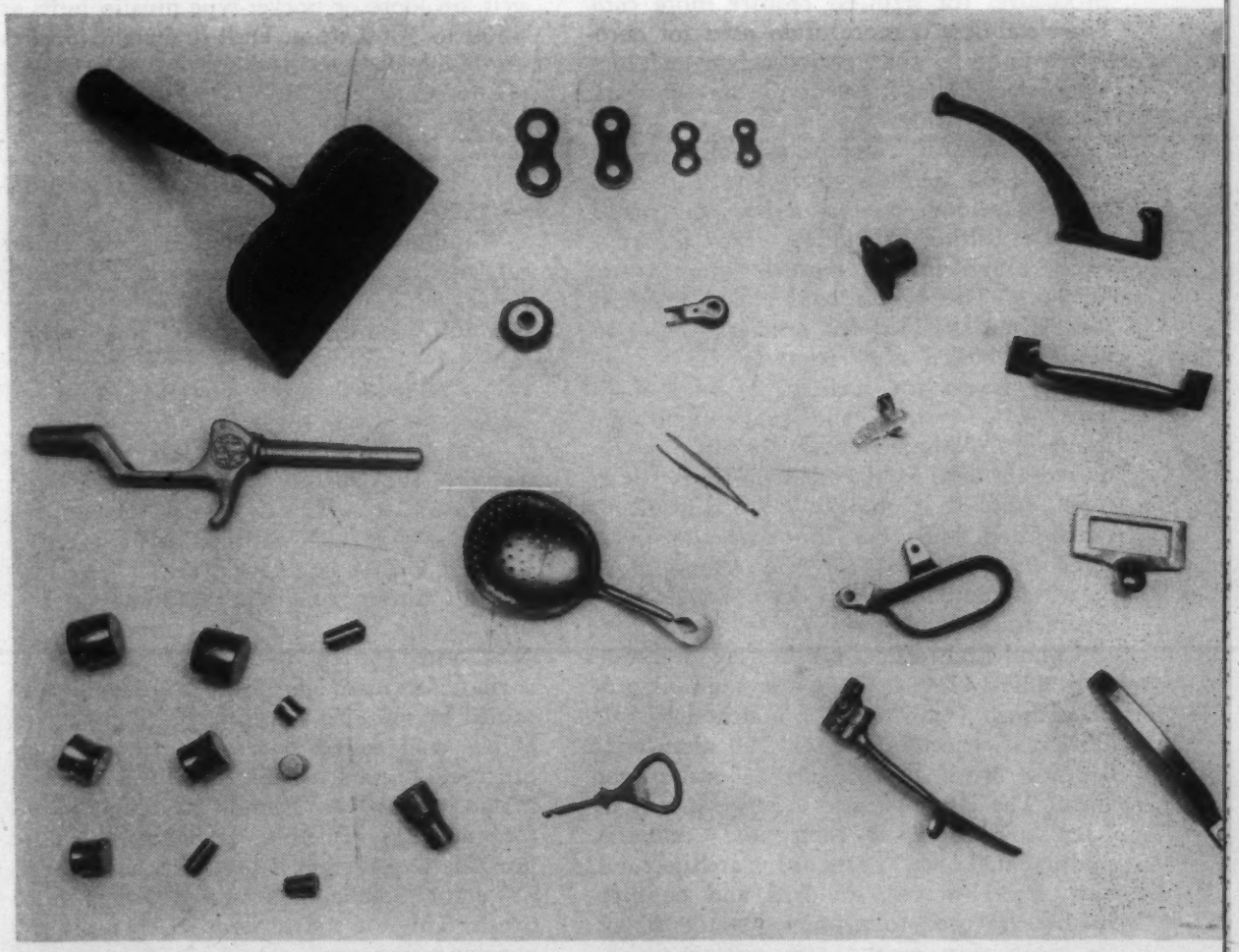
The high finish evident on these parts was produced by wet tumbling and burnishing procedures. (Courtesy Roto-Finish Co.)

strength of machine parts are well known. Not so familiar, perhaps, is the use of blasting techniques to produce desirable end finishes on metals.

The differences implied by the use of such terms as sandblasting, shotblasting and gritblasting are mainly differences in the material used as ammunition. Sand, of course, refers to ordinary silica sand. Shot commonly used includes steel, chilled iron, heat treated cast iron, malleable iron and copper spheres. Grits sometimes used are soft materials such as walnut shells, macerated corn cobs, apricot pits, glass beads and plastics, or hard abrasives such as alumina or cast iron chips.

Metal shot produces a coarse, dented surface, each shot acting as a tiny peen hammer. Abrasive grits, on the other hand, tend to produce a fine, scratched surface. By proper selection of size and type of abrasive, a wide variety of finishes, from fine to coarse, can be obtained. Light metal parts can be given a satin finish, and finishes required for enameling, galvanizing, painting and similar processes can also be produced.

Principal factors governing the results achieved from blasting are work coverage and size, impact, cleanliness, quality and direction of the ammunition. Size of the ammunition is determined by the type of work being blasted, and the fineness of finish desired. Finer finishes are obtained by reducing shot or grit size; in the case of thin sheet, small shot sizes are sometimes essential to prevent warping. For fillets, shot radius should be about one-half that of the fillet.



Different degrees of surface finish can be produced by careful control of the tumbling process. (Courtesy Norton Co.)

Work coverage involves the quantity of ammunition used and its distribution across the surface. Coverage is, therefore, affected by the impelling equipment used. Shot cleanliness is important because of the cutting action of broken pieces and the reduced effectiveness of undersize pieces. Impact depends on the size and density of the shot and its volume and direction of application relative to the work. The energy absorbed by the work, of course, varies with the angle between the shot stream and the work. Other significant factors are hardness, impact strength and shape of the shot.

There are two styles of shot or grit blasting equipment—air and airless. In one case the shot is hurled from the rim of a rotating wheel, while in the other it is impelled by compressed air. Airless blast gives a long, narrow shot stream of uniform intensity, and velocity and distribution are closely governed. In the wheel method it is necessary to move the work through the stream. Air blast is characterized by much greater variations in intensity through the stream. The target space can be changed by changing orifices or by moving the shot stream. Airless blast is the cheaper process and is, therefore, used wherever possible; however, it loses some of its efficiency when used with soft grits. Air blast is especially adapted to small areas or areas not easily reached with the airless stream. Where only certain areas are to be shot blasted, parts to remain untouched can be masked with hard rubber (70-80 Durometer hardness) or high-speed steel (60 to 65 Rockwell C). Softer blasting materials can be used for nonmetallic grits.

Shot and Grits—An indication of the broad range of materials used for blast ammunition has been given above. Of the

metal shots, chilled iron was originally most popular, particularly for hardened work. However, brittleness of this material has been responsible for the development of heat treated cast iron shot which is much tougher, and the imbedding of chilled iron slivers in soft metals has resulted in the use of malleable iron for such work. Latest development has been the use of copper shot for nonferrous metals; this not only prevents imbedding of hard particles but also the rusting and discoloration resulting from residual iron dust.

Soft grits are not recommended for polishing metal surfaces where gloss or high luster are desired. However, hot-dip tinned and other plated parts acquire a satin finish even under extremely mild blasting conditions. It is possible that continued experimentation with soft grits and blasting techniques may result in acceptable fine polishing and burnishing procedures.

Liquid Blasting—Blasting by means of abrasives suspended in water is known as liquid blasting. Results are controlled by stream velocity and direction, and type, size and quantity of abrasive. Abrasive sizes range from 100 to 5000 mesh. Almost any finish can be produced by the proper abrasive or mixture of abrasives.

Finishes on Metals and Alloys

A great number of variables involved in mechanical finishing have been discussed in the previous section. However, applicability of the basic finishing processes to the principal metals and alloys must yet be considered. Some finishes are more easily produced on one metal than another, and usually the procedures are somewhat different. This section will include further details on these procedures.

Carbon and Stainless Steel

Mechanical finishing of ordinary steel and stainless steel differs mainly in that procedures for stainless require more care. Since stainless is more often used for decorative purposes than plain carbon and low-alloy steels, major attention here will be devoted to stainless.

A number of different mill finishes are available on stainless steel. The hot rolled finish is seldom used as a base for subsequent polishing or buffing, since the relatively rough surface requires more costly finishing. The bright cold rolled finish is most often specified for articles to be polished or buffed after forming. It is commonly chosen for such items as shallow pans, serving trays, and small decorative stampings. Where severe forming is required the dull cold rolled finish is sometimes used. It is slightly more difficult to polish and buff, but the dull surface is sometimes required for the retention of drawing compounds in deep drawing or severe forming operations.

Several higher mill finishes are available on stainless sheets. These are standard polished finish (which can be matched by soft lubricated wheels with No. 150 alumina), tampico brush finish, and a semi-mirror finish. The latter is used to some extent in dairy machinery, kitchen and cafeteria equipment, soda fountains, architectural trim, etc. However, standard and tampico finishes are used to a much greater extent on sheet than is the semi-mirror finish. None of these higher finishes are economical where drawing or severe forming operations are to be performed, as the finish is partially destroyed in such operations.

A mirror finish can be produced in three to four operations, depending upon the starting surface. If the starting surface is good, a greaseless polishing operation, using No. 200 grit at 5000 to 6000 sfpm., followed by two buffing operations for cutting and color at 9000 to 10,000 sfpm., will be satisfactory. However, it will usually be necessary to polish with No. 150 grit, then 240 grit or higher, before buffing. Light buffing can usually be accomplished in one operation with a cut-and-color buffing compound and similar wheel speeds. Practically all strip used for decorative purposes, such as auto trim, stoves, refrigerators, etc., is brought up with one buffing operation.

For satin finishes it is customary to use greaseless compositions, either 150 or 200 grit, on loose or pocket-type muslin buffs at 4500 to 5000 sfpm. Dull or bright finishes are obtained by using high or low pressures on the work. "Butler" finishes are produced by 220- to 240-grit greaseless compound with a slight amount of lubricant on sewed, loose or pocket-type muslin buffs at 5000 to 5500 sfpm.

Aluminum oxide is preferred to silicon carbide for stainless because of its greater point endurance on materials of high tensile strength. Natural emery is not recommended, since it contains iron which becomes imbedded in the stainless surface and causes rust spots.

Tampico brushing can be used to produce a finish similar to the "butler" finish on silverware. A surface at least as highly polished as standard polished mill sheet is brushed with a compound of 150- to 180-grit aluminum oxide in kerosene or lard oil, or fine pumice and oil mixed to the consistency of light paste. A satisfactory surface for many purposes can also be obtained by tampico brushing on the standard bright cold rolled finish, but for parts requiring a good quality finish a starting surface of 150 grit should be obtained before tampico brushing. If a better quality finish is required, it is better to buff first to a mirror finish, then apply the tampico brush. This, of course, is a much more expensive procedure.

Cut-down buffing of stainless is done with aluminum oxide in stick or cake form (No. 320 grit or finer) and the color-buffing operation uses levigated alumina, green chromium oxide or stainless steel rouge. Buff cloth with a thread count of 86/93 is generally recommended for stainless steel. Because of the properties of stainless and the high buff speeds used, the bias or ventilated type buff is preferred to prevent scorching. Speeds up to 10,000 sfpm. are used in buffing. Titanium- and columbium-stabilized grades cannot be finished to a deep luster; the carbide structures seem to be responsible for a somewhat cloudy finish.

Barrel polishing is used on many small stainless parts such as pen points, eyelets and grommets. Ball burnishing is used on a number of items difficult to buff, including lock covers, glove compartment push buttons and similar items which must ultimately match adjacent chromium plate.

The cutting down operation in tumbling uses a mineral abrasive and generally a small quantity of soap. A mixture of alumina and pumice is often used, and a volume ratio from 2:1 to 4:1, abrasive to parts, is common. For ball burnishing, stainless steel balls and shapes are preferred, as carbon steel balls may require a subsequent passivating operation despite the insulating effect of the solution. Usual practice calls for wood-lined steel barrels turning at 30 to 60 rpm. for 1 to 8 hr. One authority recommends use of Vienna lime instead of soap, followed by a final 20-min. soap treatment. In this case an unlined, well-vented barrel must be used.

Sand-vapor blasting is sometimes used on stainless panels in building construction where both simple and intricate patterns of contrast are desired. Usually, vapor blasting gives a much smoother and finer finish than sand blasting and is better where white satin finish is required. Main drawback in both processes is contamination, which is recirculated and can result in impregnation of foreign particles in the metal surface. Difficulties can be avoided by passivating in straight nitric acid or nitric and sodium dichromate solutions.

Aluminum

Polishing of aluminum requires lower wheel speeds and finer abrasives than some of the heavier metals. In addition, its high coefficient of friction makes proper lubrication more important.

Rough polishing operations are handled either by flexible alumina paper disks or endless belts, or by semi-flexible bonded

muslin or canvas wheels plus abrasive. Abrasives used are 60- to 100-mesh emery or 60- to 120-mesh alumina. Maximum speed is 6000 sfpm. Oiling operations are performed by lubricated felt wheels with abrasive sized 100 to 160 and turning at the same speed. On plain flat work, abrasive belts containing 80-, 120-, 140- and 180-mesh grit are used with a lubricant of tallow and lard oil or a thin paste of paraffin and kerosene. No. 80 silicon carbide on flexible paper is sometimes used without lubrication for roughing operations.

Sand castings always require roughing operations, but die castings and fabricated articles do not unless surfaces are unusually marked. Usually, a single oiling operation is sufficient, but a higher polish can be obtained by using No. 100 followed by 220.

Buffing of aluminum is done by loose or stitched muslin wheels with paper separators, charged with tripoli, silica or a mixture held with grease or a water-soluble binder and turning at 7000 to 7500 sfpm. Coloring to a silvery white luster is done by open muslin or flannel wheels, turning at 7500 to 8000 sfpm. and charged with Vienna lime, white silica or rouge. Aluminum is usually given a light caustic etch between buffing and coloring in preparation for anodizing to remove imbedded abrasive.

Brushes used on aluminum are generally 10 in. in dia. or less, composed of 0.015-in. wire, and turn at 2000 rpm. Wires of brass, stainless steel, nickel or German silver are employed. Before a casting is scratch-brushed, its surface should be given a "dust" blast; if the surface is exceptionally rough, a medium sand blast may be necessary. For castings the brush wheel speed should be much slower—about 500 to 600 rpm. Brushed parts should be immersed in concentrated nitric acid to dissolve out imbedded wire particles that would otherwise provide a potential nucleus for local attack if the part should be subjected to corrosive conditions.

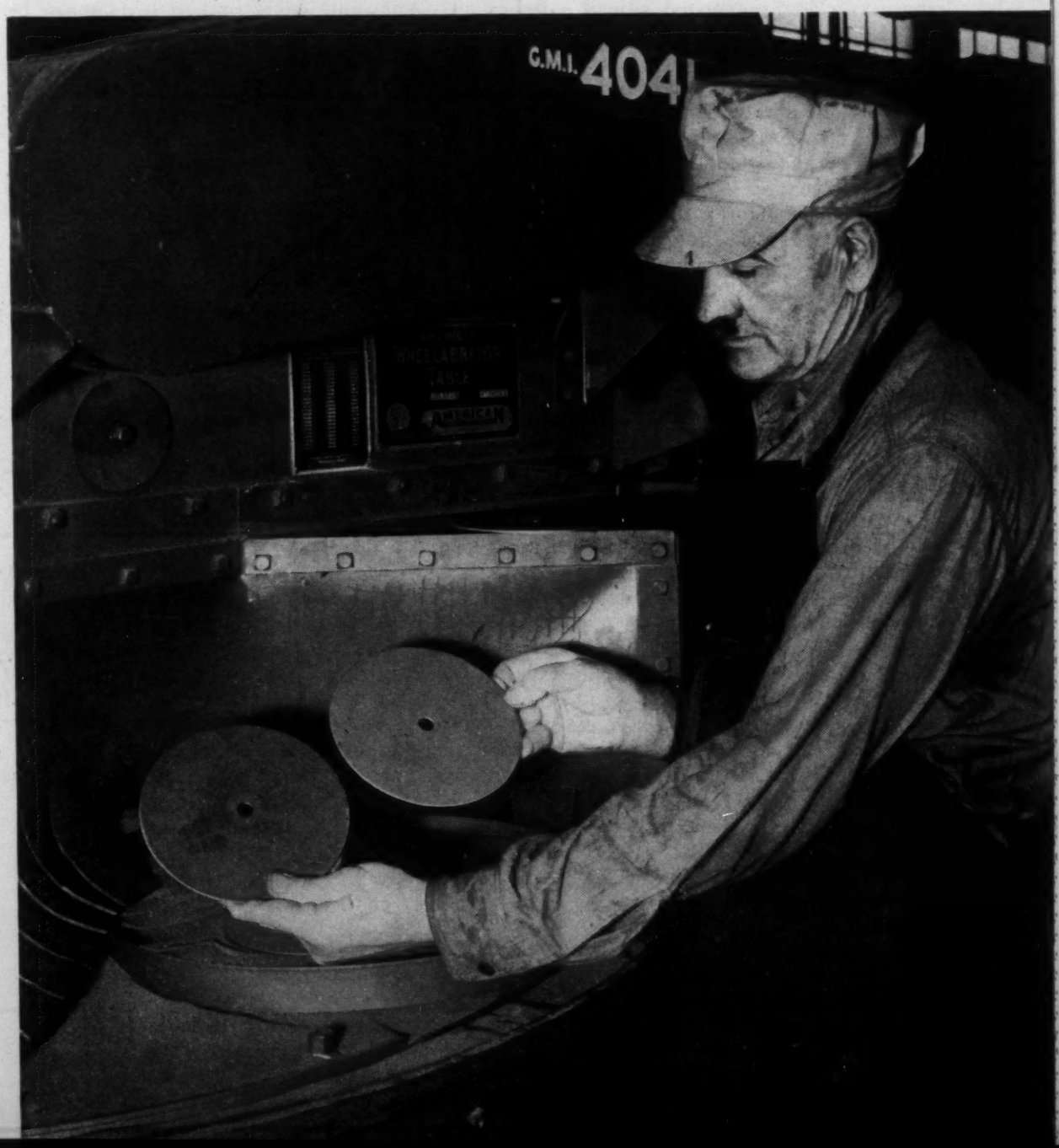
Finer wires—generally 0.002- to 0.005-in. dia.—must be used to produce a satin finish. Polishing with No. 120 or 180 emery, then buffing, provides a good base for a wire brush satin finish. On large surfaces, however, a fine sand blast is needed first. A fine finish can be obtained by a rotating fiber brush or hand rubbing with pumice and oil paste. A finish closely approximating a satin finish can be obtained by belt sanding with 80, 120, 180 and 240 emery at 2400 to 3000 sfpm. and hand finishing with pumice or steel wool and kerosene. Some difficulty is encountered in applying a satin finish to large areas uniformly. Further rubbing of the satin-finished surface with steel wool, dipped in oil and emery powder, plus cleaning with a rag while the article is still revolving, gives an attractive silvery effect. Steel wool, lubricated with soapy water or a greaseless polishing compound, can also be used to satin finish aluminum. Satin finishing of aluminum castings is best accomplished by polishing and buffing, using felt wheels with greaseless compositions.

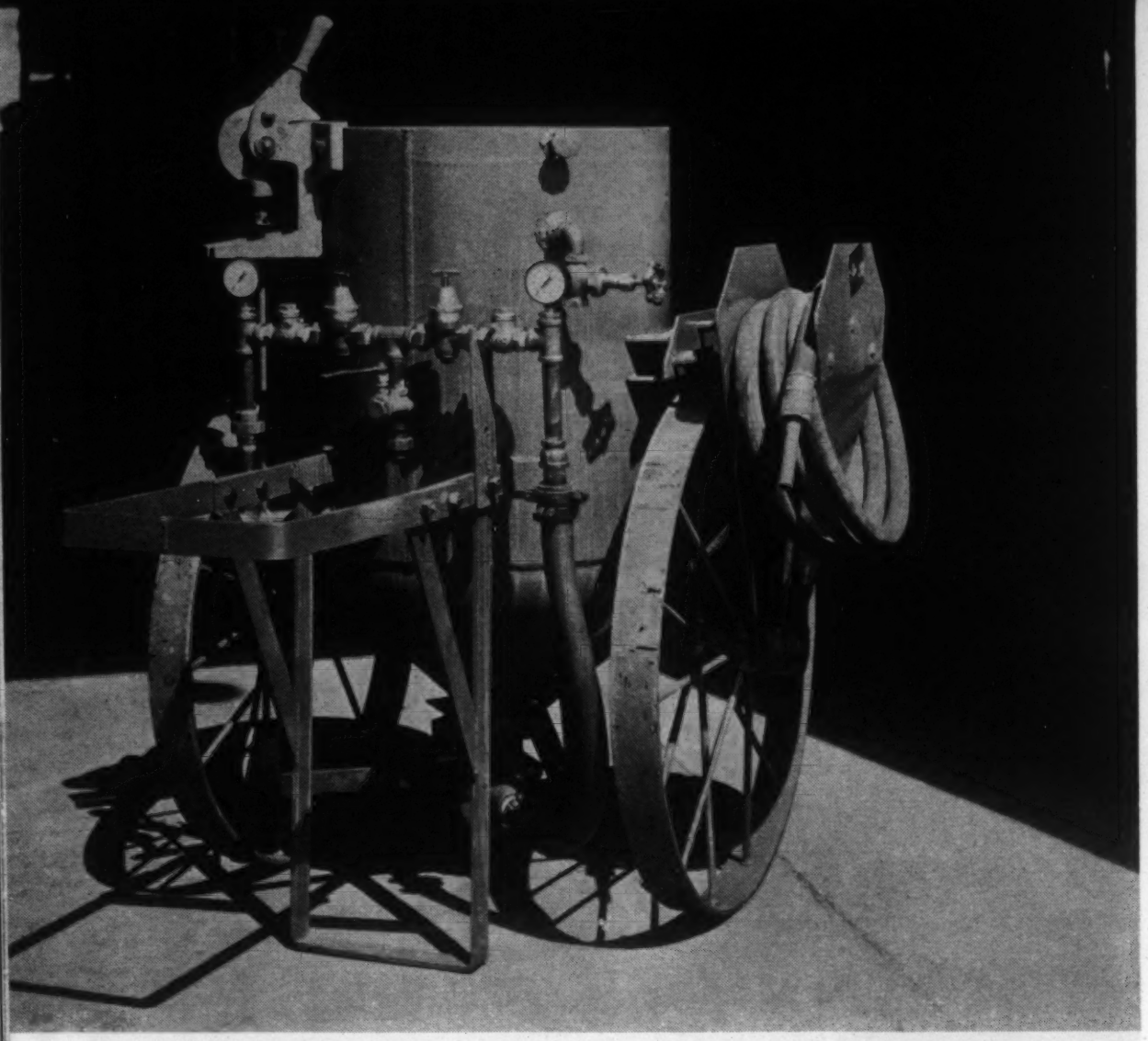
The inside of aluminum ware is often spin finished. This is done by revolving the object while pressing an abrasive cloth against it. Still turning, the object is rubbed with fine stainless steel wool dipped in oil, followed by fine mesh emery and a clean cloth. This produces a bright silvery finish. The same effect can be obtained from fine stainless steel wool lubricated with soapy water and greaseless polishing compounds.

Uniform matte finishes can be produced inexpensively and rapidly by sand blasting.

Tumbling to improve surface appearance is becoming an important part of many plant operations, and set-ups like this are not uncommon. (Courtesy Roto-Finish Co.)

A surface suitable for chromium plating is produced by this airless blast machine. (Courtesy American Wheelabrator & Equipment Corp.)





This portable blast machine was designed especially for economical handling of soft abrasives such as ground corn cobs, walnut hulls, etc. (Courtesy Pangborn Corp.)

Varying color effects (following anodizing) can be produced by using different abrasives. Silicon sand and steel shot produce a light gray color, pulverized silicon a light blue cast, and silicon carbide a dark gray color. Metallic abrasives are generally not favored, as embedded particles in aluminum may cause discoloration or corrosion. The resulting surface is rough and should be protected by anodizing or by varnish or a clear plastic coating.

Four standard blast finishes are commonly specified. A coarse finish can be produced with 6- to 20-mesh crushed silica at a pressure of 30 to 90 psi., 12- to 20-in. distance and 60- to 90-deg. angle with the surface. A medium finish is obtained with 40 to 80 grit, 30 to 90 psi. and 8- to 14-in. distance. Fine finish requires 100 to 200 mesh and 30 to 75 psi. The abrasive should be 20% coarse in order to maintain fluidity. (A comparable finish can be produced by flint shot-sand partly broken down from use at 30 to 80 psi.) Where low pressures must be used to avoid warping sheet, grit smaller than 200 mesh at 45 psi. and distance of 8 to 12 in. produces an extremely fine finish.

Attractive finishes can be produced by high lighting, widely used in architecture, refrigerator evaporator doors, panels and other hardware. Essentially it involves combining polishing and buffing with blasting to produce contrasting finishes. For example, background areas can be "dust" blasted while raised or embossed areas are protected by adhesive tape, lacquer or stencil. This background can be bleached by caustic treatment, and this is necessary to assure uniformity in anodizing. Then the highlights on other areas can be brought out by satin finishing or buffing. It is customary to anodize all surfaces. In this way comparatively white surfaces can be obtained on aluminum and certain of its alloys.

A bright, fairly smooth surface can be produced on aluminum by ball burnishing. Steel shot about 5/32 in. in dia., in a volume twice that of the work, is used. A typical cycle is 30 min. to 1½ hr. in soap solution at 30 rpm., drain, tumble, rinse in hot water, drain, then roll in fresh soap for 1 hr. Increased time for the last step will give a finer finish. Further brightening can also be secured by tumbling in hard wood sawdust about 20 min. Parts dipped will require more time to develop a bright surface than parts with machined surfaces, as the dip roughens the surface whereas the machined surface is somewhat bright to begin with.

A relatively inexpensive satin finish can be produced on large flat areas by sand burnishing. The burnishing action is produced by rotating or reciprocating travel of a burnishing table or box over stationary aluminum sheet, the abrasive being sand suspended in water.

Hammered finishes are used frequently on novelty and gift items of aluminum. The finish resembles that on hand wrought silver or hammered copper. Irregular depressed patterns can be produced by ball peen hammers or similar tools. One technique consists of heating aluminum in a smoky coal fire and hammering it while the work is covered with a fine layer of soot. Part of the black layer is embedded in the metal, after which raised areas of the work can be relieved by abrading them lightly with emery cloth or steel wool. This results in a mottled effect.

Certain special finishes are available from the mill; these include embossed and fluted designs. Embossed finishes are formed by raising certain areas of the metal in dies. Standard patterns include diamond, square, stucco, ribbed, herringbone, etc. In addition to attractiveness, embossed finishes eliminate undesirable reflections, highlights, fingerprints, etc. Fluting is an inexpensive finish produced at the mill by rolling parallel lines into sheet. This finish effectively hides structure markings on aluminum that is subsequently to be anodized for protective or decorative reasons.

Magnesium

Magnesium and its alloys show good resistance to corrosion in most atmospheres, but the protective film that is formed does not remain metallic in appearance. Instead it changes gradually to light gray. Therefore, chemical or electrochemical treatments are generally used, their luster depending upon the mechanical finish previously developed. In general, mechanical finishing procedures for magnesium differ only slightly from those used on aluminum.

Polishing is performed on wheels or belts moving at 4000 to 6000 sfpm. Final polishing before buffing is normally done by greaseless polishing compounds applied to sewed or string buffs operated at 4000 to 6500 sfpm. For many parts, greaseless compounds can be used alone before the buffing step. Unfortunately, grinding and polishing of magnesium produces a highly inflammable dust which, in proper proportions with air, can ignite with explosive violence. This dust must be removed from the working area by a dust collecting system of proper design.

Cutting down in buffing is performed by free-cutting tripoli on loosely sewed buffs to prevent dragging. Best results are obtained on 74- to 82-count cloth buffs, 10- to 14-in. dia., operating at 6000 to 8000 sfpm. Coloring is performed with dry lime compounds on 12- to 16-in. Canton flannel buffs running at 8000 to 12,000 sfpm.

Where scratch brushing is used to improve surface appearance, wires 0.003 to 0.005 in. in dia. are normally employed. Wheels 6- to 10-in. dia. with bristles 2 to 4 in. long are operated at about 1700 rpm. Long bristles are usually employed, as short bristles tend to pit the surface.

Wet tumbling of magnesium to a "polished" finish requires 3 to 8 hr. in most cases, although this time can be cut by previous grinding. Further brightening can be accomplished in 1 to 3 hr., and highest luster is produced by a final 1-hr. coloring operation.

Soft grits, such as rice hulls and macerated corn cobs, are used to a limited extent in blast finishes on magnesium.

Copper

Mechanical finishes on brasses, bronzes, nickel silvers and copper-nickel alloys must be preserved in one way or another if the original appearance is to be maintained. With no protection, copper and copper-base alloys tarnish, show finger prints, and become covered with green carbonates. Most copper alloy parts are either plated or clear

lacquered to preserve their original finish. In the case of large installations where lacquering is not feasible or where the natural oxidation colors of copper are desirable, of course, no further operations are required.

Cloth, felt and sheepskin polishing wheels loaded with alumina or emery are used on copper alloys at speeds ranging from 6000 to 9000 sfpm. The more expensive felt wheels are generally used only where a shaped bob is needed for inside polishing, and these speeds run about 4000 to 5000 sfpm. Belt polishing calls for somewhat higher speeds—8000 to 12,000 sfpm.—and contact wheels of medium density. Greaseless polishing and sand-bobbing are other techniques often used on copper alloys.

Buffing compounds vary according to the specific finish wanted. Tripoli is used for cutting down, while lime and white diamond, with their cut-and-color action, produce a surface suitable for plating. Red rouge is used for high luster where parts are subsequently clear-lacquered. Buffing speeds vary from 6000 to 10,000 sfpm. or more. Belt buffing, using a woven cotton belt traveling at 6000 sfpm., is sometimes used for intricate shapes.

Satin and "butler" finishes are now generally produced by means of greaseless polishing. A fine emery belt can also be used. Somewhat brighter finishes, however, are obtained by scratch brushing. Where applicable, brushing is most often done without abrasive, using wire wheels of brass, nickel-silver or steel. A similar finish can be obtained with the tampico wheel and emery paste. Copper alloy parts are often acid-dipped before scratch brushing.

Before any tumbling cycle, work should be degreased by rolling in hot water with caustic soda and sodium cyanide, followed by rinsing. This operation is sometimes carried out in the barrel. A fairly bright finish can be obtained by bright rolling in water and cream of tartar (potassium borotartrate), but highest luster is produced by ball burnishing. The burnishing operation is conducted at about 30 rpm. in neutral soap solution, and requires 6 to 48 hr. A favorite combination of burnishing lubricants for copper is cream of tartar and soapbark.

Shot and sand blasting are seldom used on copper alloys for decorative purposes. Hammering and engine turning are used primarily on consumer specialties. For example, auto dashboard surfaces, vanity cases and rouge boxes are often finished by engine turning. Special machines and techniques are required for this operation.

Nickel

Monel, nickel and Inconel cold-rolled sheet can be obtained from the mill in two finishes—plain (as rolled) and "silvery satin".

Where cold-rolled sheet is used for cabinet work, the surface can usually be polished easily in a short series of operations. In many cases it is necessary only to buff with tripoli, then bring out the high color with white alumina or green chromium oxide. (Lime or rouge buffing compounds are not satisfactory for nickel alloys.) Optimum finish sometimes requires a preliminary "grease coloring" operation, using fine emery on loose spiral-sewed or loose-disk buffs running at 6000 to 7500 sfpm.

Inconel does not have the same bright surface on soft-temper special sheet as nickel

Sand blast is applied to an aluminum spandrel. (Courtesy Aluminum Co. of America.)

and monel. In order to develop a high finish, therefore, it is necessary to follow the longer procedure given below.

Much hospital equipment is built of nickel alloy sheet. For such applications it is necessary to start the polishing operation with No. 180 emery, followed by 180 and 220 grease wheel operations before buffing. Sometimes a tampico brush wheel with fine emery, turning at 1200 to 3000 sfpm., is used after the final polishing step; this may eliminate the tripoli operation.

Satin finishes are now much more popular than buffed finishes. They can be obtained in several ways. One method is to cut down with a fine (180 or 200) emery grease wheel, then use a tampico wheel charged with fine emery grease cake or run a tampico brush over a grout (oil and emery mixture) on the surface. Or, the final operation can be performed by a greaseless compound on a high-count loose-disk muslin buff; this is more often used on small formed parts than on sheets. Another method involves hand rubbing the surface with No. 180 paper, followed either by rubbing with a soft felt pad dipped in a paste of medium oil and then flour emery, or by wetting the surface with No. 180 paper, followed either by rubbing with a soft felt pad dipped in a paste of medium oil and then flour emery, or by wetting the surface with a 2:1 solution of kerosene and medium oil and rubbing with No. 240 paper. A less satisfactory satin finish can be produced by wire brushing, but this method is generally used only on ornamental castings. All wire brushing should be done with nickel-silver or stainless steel to minimize rusting or discoloration of foreign particles imbedded in the surface.

Drawn or stamped parts are sometimes polished with pumice and oil on a walrus hide wheel. Techniques here are similar to those used on sterling silver-plated ware.

Effective satin or mirror finishes require a final light buffing operation which actually amounts to a cleaning job. It is performed with Venetian lime (whiting) on a Canton flannel cloth.

Tumbled finishes are often produced on nickel alloy parts. Cutting down and smoothing are done with fused alumina media, while steel balls and needles provide burnishing action. Matte finishes can be produced by liquid blasting; for such applications, nonmetallic media are generally preferred. Sand and shot blasting are usually restricted to cleaning operations.

Zinc

Because of their tendency to tarnish, zinc surfaces are generally protected by plating or other coating processes. However, a lustrous final appearance usually requires prior surface preparation.

Today the proportion of die castings requiring grinding and polishing is lower than before, because of the greatly improved finish of castings produced in highly polished dies with better casting techniques. Many zinc die castings are so smooth that, except at parting lines, only buffing is required before plating. Rolled zinc normally requires only buffing before plating.

Both natural and artificial emery abrasives are widely used on zinc, and they are generally bonded with water-soluble glue. Wax-treated wheels are sometimes used, as they soften under a small amount of heat and thereby reduce loading. Wheel size most commonly used is 14-in. dia., and usual polishing speed is about 5,000 sfpm. Most polishing is done on belts of emery cloth or its equivalent. A satin finish suitable for plating can also be obtained by means of greaseless polishing compounds.

It is essential that the tripoli used for buffing be free-cutting, since excess pressure results in dragging and waviness, especially in the case of rolled zinc. It is always important in selecting a buffing compound for die castings to consider the compatibility of the compound binder with the cleaning system that is to follow. The coloring compound used on die castings should be dry and lime-free, because excess grease makes cleaning difficult and lime makes both cleaning and rinsing hard. In many cases no coloring compound is used; instead, the work is given a dry wipe on a portion of the buffing wheel face left free of compound. The commonly used buffing speed for die castings and rolled zinc is 5,000 sfpm. Higher speeds on rolled zinc tend to cause dragging. Speed on die castings is not so critical, but overly high speeds may result in loading and dragging.

Satin finishes can also be produced by dry tumbling with abrasive, dry lubricant and wood chips as a carrier. Sometimes proper sequence of abrasives gives a surface suitable for plating; however, a final buffing operation may be needed. Small die castings can be dry burnished in 18 to 36 hr. and large parts in 23 to 40 hr. Wet burnishing, on the other hand, can be carried out in 20 min. to 3 hr. A typical charge is: 500 to 1,000 small castings weighing 150 lb.; 400 lb. of ⅛-in. steel balls; and 50 gal. of water containing soap and sodium cyanide. Barrel speed is 13 rpm.

Precious Metals

Where precious metal objects have sharp corners to be preserved or large, essentially flat areas, lapping is usually the best finishing method. Felt wheels, ¼- to 10-in. dia., turning at 2000 to 3450 rpm., are used with tripoli or a mixture of No. 600 alumina and stearic acid. Lapping can be supplemented by buffing, or buffing can be used instead of lapping on objects with rounded contours. For this work, cotton buffs counting 64/68 charged with tripoli are used. Similar results can be obtained by brushing where the objects are quite irregular or where decorations have appreciable depth. China hog-bristle brushes, 3½-in. dia., turning at 3450 rpm., are used with greasy red rouge.

Following lapping or cutting buffing, buffing with greasy rouge and color buffing with dry rouge are suitable for the usual gold and silver alloys, and provide the final finish desired. Separate wheels must be used for platinum and palladium to avoid transferring particles of gold to them and causing a slight yellow cast. The tripoli cutting down operation should be followed by cleaning in hot water containing soap and ammonia. Then white rouge is used and the metal cleaned as before. Red rouge is not desirable on platinum metals.

Satin finishes can be produced by wheel or hand methods. One method requires cotton buffs, counting 64/68, rotating at 1750 rpm., and charged with No. 240 greaseless polishing compound. Another involves No. 240 or 320 emery cloth and hand abrading.

Scratch brushing is performed by brushes having wires of German silver or brass, rotating at 1800 rpm. and lubricated by warm water or soap bark.

High Temperature Alloys

High temperature alloys are generally characterized by a high coefficient of expansion and low thermal conductivity. In order to avoid distortion caused by localized overheating, free-cutting wheels are used for polishing. Excess pressure on the wheel is avoided, and the wheel is kept in motion across the work at all times.

On iron-base alloys, a satin finish can be obtained with a fine grain wheel bonded with rubber. Buffing is done with a flat, medium-weight or medium-soft wheel loaded with crocus.

Cobalt-base alloys are polished by a composition wheel coated with 80 to 220 grit, turning at 7000 sfpm. A 14-in. muslin buff charged with No. 220 emery is used for cutting down in buffing, and crocus is used for coloring at 3500 rpm.

Tungsten carbide is best finished by a copper lap and diamond dust, 600 to 1000 mesh. The finer the dust, the higher the brilliance produced.

Acknowledgment

The assistance provided by the literature and personnel of the following companies in the preparation of this Manual is acknowledged with appreciation:

Abbott Ball Co.
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American Wheelabrator & Equipment Corp.
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The Bullard Co.
Carpenter Steel Co., The
Chase Brass & Copper Co., Inc.
Divine Bros. Co.
Dow Chemical Co.
Eastern Stainless Steel Corp.
Enthone, Inc.
Formax Mfg. Corp.
General Abrasive Co., Inc.
Gisholt Machine Co.
Grinding Wheel Institute
Hammond Machinery Builders, Inc.
Hanson-Van Winkle-Munning Co.
Haynes Stellite Div., Union Carbide & Carbon Co.
International Nickel Co., Inc., The
Jones & Laughlin Steel Corp.
Lupomatic Industries, Inc.
Lea Mfg. Co.
Mid-West Abrasive Co.
D. J. Murray Mfg. Co.
Mecha-Finish Corp.
New Jersey Zinc Co., The
Newark Brush Co.
Norton Co.
Osborn Mfg. Co.
Pangborn Corp.
Pratt & Whitney Div.
Raybestos-Manhattan, Inc.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Roto-Finish Co.
Simonds Abrasive Co.

Materials Engineering File Facts

NUMBER 201
November, 1950

Precision Investment Nonferrous Casting Alloys

To aid in the selection of the proper alloys for precision investment castings, one of the leading companies in the field has compiled the data in the table below. All values are typical, but are not guaranteed.

Copper Alloys

Name	Nominal Comp., %	Physical Properties				Mechanical Properties (Annealed)					
		Sp.Gr.	Ther. Exp./F	Ther. Cond.	%IACS	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	End., 1000 Psi.	Impact, Ft.Lb.	Bhn.
Aluminum-Bronze	86.9 Cu min., 10 Al, 1.10 Fe, 1.00 Mn, bal. Zn	8.15	9.5×10^{-6}	35	14	30	70	30	—	33	130
Beryllium-Copper	2.75 Be, 0.12 Fe, 1.10 Ni, bal. Cu	8.23	17.2×10^{-6}	49	15	25	70	50	32.5	5	135
Die-Cast Brass	60 Cu, 1.25 Pb, 0.75 Fe, 0.75 Sn, 0.15 Al, 0.05 P, 0.50 Ni, bal. Zn	8.40	12.0×10^{-6}	—	25	—	—	—	—	30	140
Electrolyte Copper	99.9 Cu min., 0.001 Be max., 0.003 S max.	8.91	9.8×10^{-6}	225	101	10	32	50	10	38	—
Manganese-Bronze	57.5 Cu, 1.00 Al, 1.00 Fe, 1.50 Mn, 0.50 Ni max., 0.30 Pb max., 1.00 Sn max., bal. Zn	8.20	12.0×10^{-6}	61	18	25	70	30	—	30	140
Naval Brass	60.5 Cu, 0.10 Fe max., 0.20 Pb max., 0.75 Sn, bal. Zn	8.41	11.8×10^{-6}	67	25	25	57	50	15	—	120
Nickel Silver	65 Cu, 20.5 Ni, 4.0 Sn, 1.00 Fe max., 4.0 Pb, 0.5 S, 0.25 Sb, 0.05 Si, bal. Zn	8.85	9.0×10^{-6}	14	6	25	40	15	5	20	105
Phosphor-Bronze	8.0 Sn, 0.10 Fe max., 0.15 P, 0.05 Pb max., 0.20 Zn max., bal. Cu	8.80	10.1×10^{-6}	36	13	16	35	—	—	10	65
Silicon Bronze	94.8 Cu min., 1.60 Fe, 1.50 Mn, 0.60 Ni, 0.05 Pb, 3.20 Si, 0.75 Sn, 1.00 Zn	8.53	10.0×10^{-6}	21	7	22	55	50	30	—	75

Cobalt Alloys

Name	Nominal Comp., %	Physical Properties			Mechanical Properties					
					As Cast			Age Hardened		
		Sp.Gr.	Ther. Exp./F	Ther. Cond.	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	Yld., 1000 Psi.	Ult. 1000 Psi.	Elong., %
Stellite No. 21	27.0 Cr, 5.5 Mo, 2.5 Ni, 0.25 C	8.30	8.38×10^{-6}	10.08	63.5	101	8.2	64	124	1.7
Stellite No. 31	25.0 Cr, 10.0 Ni, 2.0 Fe, 8.0 W, 0.50 C	8.61	8.75×10^{-6}	10.17	51	113	8.0	68	128.3	2.0
Tantung G	30.0 Cr, 16.0 W, 3.0 C, 2.0 Mn, 4.0 Fe, 5.0 Ta or Cb	—	7.5×10^{-6}	15.49	—	65	—	—	—	—

(Continued on page 99)

Ask your B&W Tube Representative . . . he knows

Because it has all the attributes of its seamless counterpart, B&W Welded Tubing in Carbon and Stainless Steel grades lends itself readily to hundreds of applications. Saves money, too . . . . .

FOR EXAMPLE: If your tubing requirements fall within the available range of diameters and wall thicknesses, you will find it economical to purchase B&W Welded Carbon or Welded Stainless Steel Tubing. Because B&W produces both Seamless & Welded Tubing, its representatives can make completely unbiased recommendations of the type best suited for your specific fabrication requirements.

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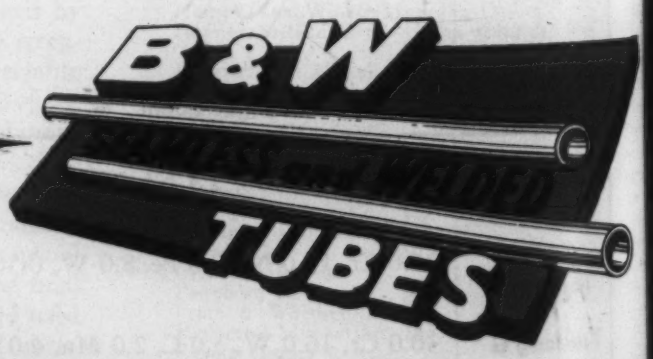

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TA-1564-G

Materials Engineering File Facts

NUMBER 201—(Continued) PRECISION INVESTMENT NONFERROUS CASTING ALLOYS

Aluminum Alloys

Name & Source	Nominal Comp., %	Physical Properties				Mechanical Properties									
						Annealed					Aged				
		Sp.Gr.	Ther. Exp./F	Sp.Ht.	Elect. Res.	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	Bhn.	End., 1000 Psi.	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	Bhn.	End., 1000 Psi.
142 Alcoa	4.0 Cu, 1.00 Fe, 1.5 Mg, 0.10 Mn, 2.0 Ni, 0.80 Si, 0.20 Ti, 0.03 Zn	2.73	12.5×10^{-6}	0.23	4.60	18	27	1.0	70	6.5	34	40	1.0	105	10.5
220 Alcoa	10.0 Mg, 0.20 Cu, 0.30 Fe, 0.10 Mn, 0.20 Si, 0.10 Zn	2.58	13.6×10^{-6}	0.23	8.21	25	46	14.0	75	7	—	—	—	—	—
355 Alcoa	5.0 Si, 1.00 Cu, 0.60 Fe, 0.50 Mg, 0.10 Mn, 0.20 Ti, 0.10 Zn	2.70	12.2×10^{-6}	0.23	4.79	24	30	2.0	75	—	27	43	4.0	90	9
356 Alcoa	7.0 Si, 0.20 Cu, 0.60 Fe, 0.30 Mg, 0.10 Mn, 0.20 Ti, 0.10 Zn	2.68	11.9×10^{-6}	0.23	4.42	20	25	2.0	60	7.5	27	40	5.0	90	—
40E Frontier	5.5 Zn, 0.50 Cr, 0.30 Cu, 0.30 Fe, 0.60 Mg, 0.30 Mn, 0.20 Ti	2.81	13.7×10^{-6}	0.23	4.93	25	35	5.0	80	9	—	—	—	—	—

Nickel Alloys

Name	Nominal Comp., %	Physical Properties				Mechanical Properties							
						As Cast				Heat Treated			
		Sp.Gr.	Ther. Exp./F	Ther. Cond.	%IACS	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	Bhn.	Yld., 1000 Psi.	Ult., 1000 Psi.	Elong., %	Bhn.
Electro-Nickel	99.95 Ni, 0.02 Cu, 0.02 Fe	8.90	7.4×10^{-6}	53	25.5	25	55	50	125	—	—	—	—
Beryllium-Nickel	2.75 Be, 0.50 C max., 0.75 Cu, bal. Ni	8.36	6.4×10^{-6}	—	5.0	90	120	10	225	175	230	—	515
Inconel	77.5 Ni, 2.00 Si, 13.5 Cr, 6.0 Fe, 0.25 Cu, 0.80 Mn, 0.20 C, 0.01 S max.	8.30	7.2×10^{-6}	15	3.5	40	90	20	190	130	155	5	260
Monel	60 Ni min., 3.5 Fe max., 2.3 Cu min., 2.0 Si, 0.50 Al max.	8.63	7.3×10^{-6}	15	—	35	80	30	150	85	105	5	240

Courtesy Precision Metalsmiths, Inc.

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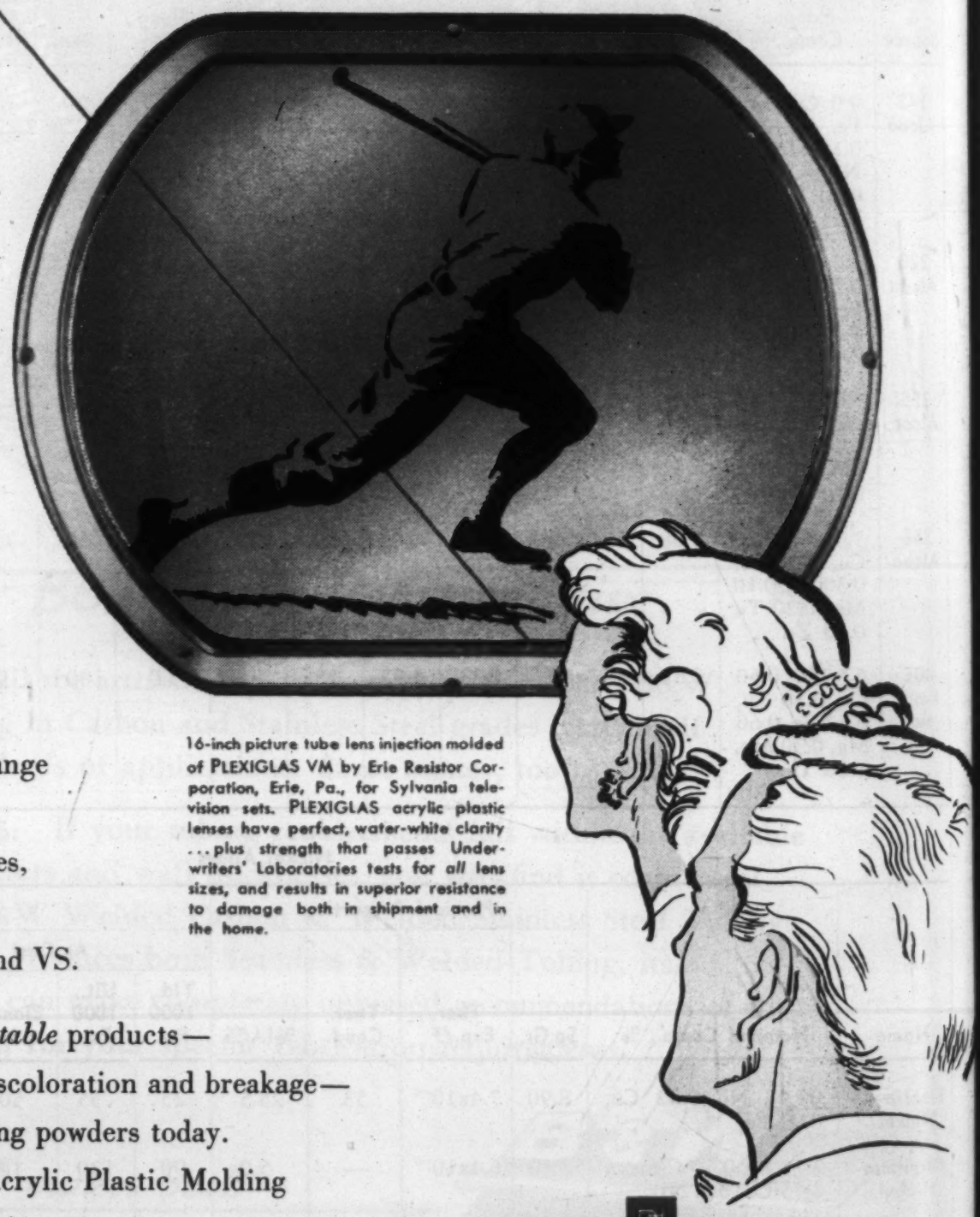

16-inch picture tube lens injection molded of PLEXIGLAS VM by Erie Resistor Corporation, Erie, Pa., for Sylvania television sets. PLEXIGLAS acrylic plastic lenses have perfect, water-white clarity ... plus strength that passes Underwriters' Laboratories tests for *all* lens sizes, and results in superior resistance to damage both in shipment and in the home.

When you want customers to look *at*—or look *through*—your product, specify PLEXIGLAS molding powder. This acrylic material makes clear or colored decorative pieces gleam like jewels. And in lenses, transparent sections, housings, true optical clarity is assured.

The excellent flow characteristics of PLEXIGLAS powders permit satisfactory molding over a wide range of temperatures and pressures. We offer 3 different injection grades, each developed to meet specific requirements—PLEXIGLAS V, VM and VS.

For injection molding of *durable*, *stable* products—resistant to high heat, weather, discoloration and breakage—get full details of PLEXIGLAS molding powders today. Our newest booklet, "PLEXIGLAS Acrylic Plastic Molding Powders", gives complete information.

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New Materials and Equipment

Materials

olybdenum-Base Lubricant

Several new forms of the recently-introced molybdenum-base lubricant have en made available by the *Lockrey Co.*, ubricants Div., College Point, N. Y.

One of these, Liqui-Moly, is a specially eated compound of molybdenum, which s the peculiar property of attaching itself molecular attraction to metal-bearing faces and forming a lubricating film that nnot be eliminated by any amount of essure. In addition, it can withstand wide nges of temperatures without its lubricatg qualities being affected.

In Liqui-Moly, the molybdenum has been corporated into a volatile liquid having e appearance of oil. This liquid serves to nsport the metallic lubricant to the bearg surface. There it evaporates, leaving a ating of molybdenum. The result is said be a dry, but well-lubricated bearing, fe at extreme pressures, speeds and temratures. One example given by the manucturer is the use of Liqui-Moly as a lubrint in the hot extrusion of steel at 2250 F, here bearings are run continuously at red at without affecting its lubricating qualis.

Another new form is Liqui-Moly NV egular and Grease which is incorporated a liquid glycol derivative that will pour temperatures as low as 25 F. Qualities of is product include long life, chemical inness, and freedom from carbon, sludge, varnish and, according to the manufacrer, make it as near to a permanent lubrint as can be produced.

Liqui-Moly NV thread compound takes vantage of the ability of molybdenum to event metals from seizing or freezing toher under extreme pressure to provide lubricant that is said to make it possible disassemble any piping or other threaded aterial without damage to the equipment. pe and thread joints can be made up tighter with less torque or danger of damage, and disassembled with less pressure than the make-up required, according to the manufacturer.

The fourth new product, Moly-Wax-Stix, provides a convenient means of applying this molybdenum-base lubricant in solid form. Typical uses are for filling grooves cut in bushings or thrust washers to feed out molybdenum slowly and to lubricate glass pet-cocks, glassware connections, and wood and plastic slides.

Molding Powder

Recent modifications in Plexiglas VM acrylic molding powder have made it as easily handled for extrusion as for injection molding, according to the manufacturer, *Rohm & Haas Co.*, Washington Sq., Philadelphia 5.

Physical properties of the powder, a medium heat range material, are unchanged, but the improved formulation makes possible extrusions by standard techniques, with oven drying usually sufficient. High production rates without seed bubbles and "fisheyes" are other advantages claimed.

When supplied for extrusion applications, the powder is designated as Plexiglas VM (Extrusion Grade).

Water Soluble Cellulosic

A new water soluble cellulosie, sodium cellulose sulfate, is now being produced by *Tennessee Eastman Corp.*, 10 E. 40 St., New York 16.

Called SCS, this cellulose gum is made by treating cellulose fibers, such as wood pulp or cotton linters, with sulfuric acid and certain other reagents. The resulting granular product can be readily dissolved in hot or cold water.

As SCS is added to water, the viscosity of the solution increases rapidly—a solution containing only 2 to 3% of SCS being so thick and syrupy that it can hardly be poured from its container. If such a solution is distributed evenly over a smooth plate and the water removed by evaporation, a clear, strong, grease-proof, non-burning film is said to be produced.

Many uses in the textile, paper, paint, detergent and food industries are indicated by the properties of the cellulosic, according to the manufacturer.

Phenolic Casting Resin

Rezolin, Inc., 4825 W. Jefferson Blvd., Los Angeles, has announced a new liquid phenolic casting resin called "8000" Tool Plastic, manufactured for them by *Durez*

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New Materials and Equipment
(CONTINUED)

Plastics & Chemicals, Inc., North Tonawanda, N. Y.

Possessing unusual high dimensional stability, the casting resin is said to eliminate shrinkage encountered in previous materials of this type. Savings up to 50% in time and in the cost of production of checking fixtures, hydropress and stretchpress dies, jig bases, master models, trim and routing fixtures, Keller patterns, acrylic form dies, polyester laminating molds, and spinning chucks are claimed by the manufacturer.

Cure time for the standard mix is overnight at 190 F, with no pressure required. The finished part is infusible and insoluble, has an impact strength of 0.24 to 0.3, and a specific gravity of 1.26. Two types of accelerator paste are available for use with "8000" tool Plastic—"8000" paste and Quick Set paste. No fillers are required.

Television Tube Steel

USS 17-TV, a new stainless steel developed by *Carnegie Illinois Steel Corp.,* Carnegie Bldg., Pittsburgh, Pa., has made possible the production of rectangular television tubes said to be lighter, more economical, and more durable than previous video tubes.

The alloy, containing approximately 17% chromium, replaced a more costly stainless steel with 28% chromium composition. One of the most essential properties of USS 17-TV is its expansion and contraction rate, which parallels that of glass. Most metals expand and contract at rates different from those of glass, causing the glass to crack when the two are sealed together. In addition, the new steel is said to be easy to form and strong enough to withstand the pressures caused by the vacuum inside the television tube.

Metal envelopes are, of course, more durable than all-glass tubes for handling in manufacturing, shipping or servicing, and weigh substantially less.

Shielding Metal

A new material, called Electroshield metal, which improves the performance of electronic communication equipment by shielding it from outside interferences, has been produced by *American Cladmetals Co.,* Arch St., P. O. Box 544, Carnegie, Pa.

Consisting of a core of mild steel clad on each side with copper, Electroshield metal is made in regular sheet sizes and gages. Full size panels for shielded rooms in light and heavy sheets up to 35 sq. ft. in area are also available.

Extremely workable and easy to weld, the metal is said to be particularly effective in the lower frequency ranges now being used in advanced designs of electronics equipment.

Video Fluorescent Powders

Two groups of fluorescent powders for the development of color television picture tubes suitable for the several types of electronic color TV systems now being considered have been developed by *Sylvania Electric Products, Inc.,* 500 Fifth Ave., New York 18.

Now available in engineering sample quantities, the two groups of phosphors include sulfide and oxide types in the three basic TV colors: red, green and blue. The oxide powders are of relatively fine texture, while the sulfides have approximately the same particle size as those now used in standard black and white picture tubes.

Previously-used red phosphor mixes have lacked color depth because of relatively low brightness obtained and excessive light output in the green and blue region. With the new red phosphor, however, a decided improvement has been achieved, according to the manufacturer. The red phosphor is a manganese-activated zinc phosphate.

●

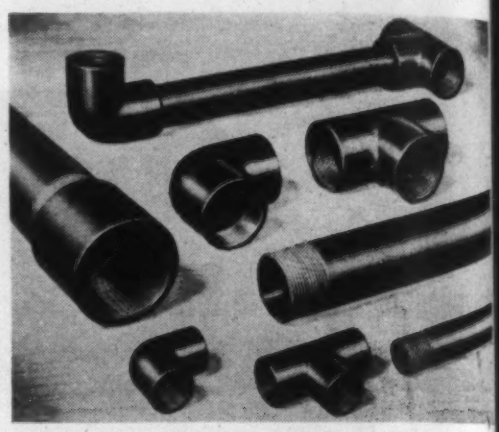
Parts & Forms

Threaded Plastic Pipe

Development of a new plastic pipe furnished in threaded sections, together with molded plastic fittings, has been announced by *Carlon Products Corp.,* 10235 Meech Ave., Cleveland 5. Designated Carlon TL, the new pipe is furnished in 20-ft. lengths and incorporates standard International Pipe Threads.

Carlon TL can be threaded and cut in the conventional manner with standard pipe-fitting tools and, because of the inherent pliability of the plastic from which the pipe is extruded, fit-up is said to be more rapid. In addition, threaded, leak-proof joints are assured.

Featuring extreme light weight (approximately 1/9 the weight of steel), Carlon TL is furnished in standard pipe diameters from ¼ to 2 in. Because of its complete immunity to rot, rust and electrolytic corrosion, the new pipe is said to be valuable for handling fluids and gasses of all types.



Carlon TL threaded plastic pipe is furnished in standard pipe diameters from ¼ to 2 in.

A complete line of plastic ells, tees, adapters and plugs is available to facilitate coupling of plastic pipe systems or to permit attachment to previously installed metal installations as well as valves, pumps, faucets, and threaded outlets or intakes.

Neoprene Belting

A new Neoprene belting that is said to be ideal for almost every kind of light conveying and transmission work is now being produced by *Baldwin Belting, Inc.,* 74-76 Murray St., New York 7.

Available in two colors, brown and white, the belting is constructed with a skin coat of Neoprene rubber between all plies of the fabric. In addition, there is a smooth Neoprene cover on one side and a special bonded edge which prevents fraying.

The new belting is said to be oilproof, waterproof, odorless, tasteless, non-toxic, washable, heat resistant, and acid and alkaline resistant. It is made in two different thicknesses, and is available in any width up to 48 in.

V-Type Packings

Crane Packing Co., Dept. L 10, 1800 Cuyler Ave., Chicago 13, has announced the perfection of V-Ring type packings molded of Teflon.

Molded by a specially developed process

MAKE A TON OF SHEET STEEL GO FARTHER

Specify—

N-A-X

HIGH-TENSILE STEEL

SEVEN STRONG REASONS

There are seven excellent reasons why users of steel prefer—and specify—N-A-X HIGH-TENSILE steel. All of these reasons help manufacturers make a ton of sheet steel go farther.

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- GOOD FORMABILITY
- EXCELLENT WELDABILITY
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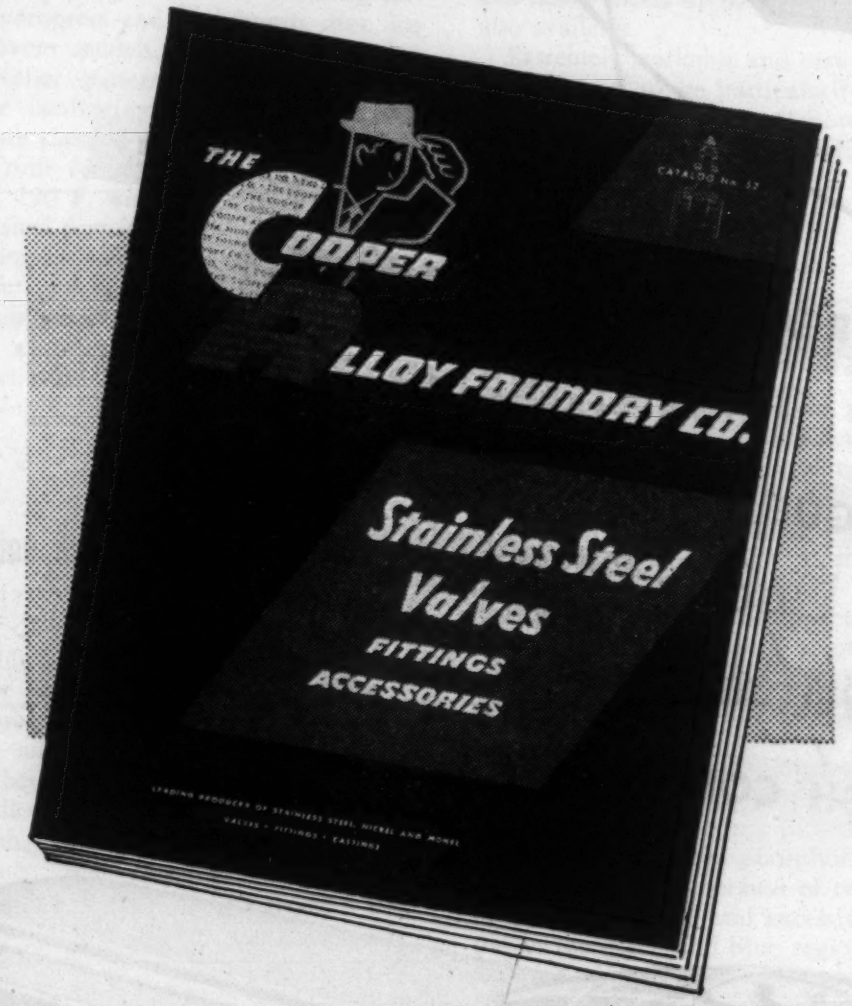


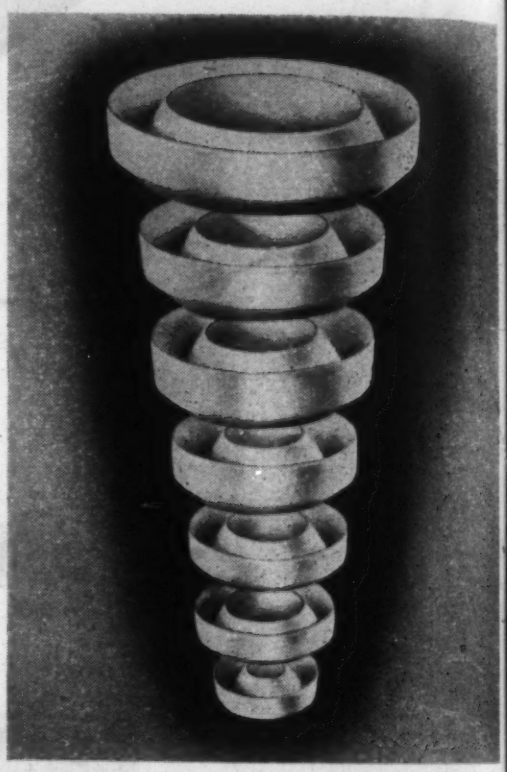
PLANNED to serve as a manual for all concerned with purchasing, design or maintenance of corrosion-resisting equipment, Cooper Alloy's new 48-page catalog gives complete data on all standard Cooper Alloy products. It includes engineering drawings, weights, dimensions, size ranges, materials, corrosion data, nomenclature and design information. Catalog #52 also contains easy-to-read charts covering the corrosion resisting ratings of stainless alloys, applications and other related information.

FREE—Write for it today • Your copy of the Cooper Alloy Stainless Steel Valves, Fittings and Accessories Catalog will be mailed to you immediately upon request.

The COOPER ALLOY Foundry CO.....leading producer of Stainless Steel VALVES • FITTINGS • CASTINGS

New Materials and Equipment

these V-type packings are said to combine the chemically inert and frictionless properties of Teflon with the resilience and toughness needed for proper sealing results. Permanent sealing is assured, according to the manufacturer, at temperatures up to 450 F.



Chemlon V-Rings are not affected by corrosive solutions and withstand temperatures up to 450 F.

Development of these rings is said to be of particular importance to valve manufacturers because of their low friction characteristics. In addition, the V-Rings are reported to stand up several times longer than conventional packings and form a perfect seal with just finger-tight pressure on the gland.

•

Coatings & Finishes

Protective Coating

Based on versatile Vinylite resins, a new protective coating for both exterior and interior use is being distributed by *Plastic Coating Corp.*, Suite 1841, 30 Rockefeller Plaza, New York City. Said to combine the advantages of superior protection, durability, economy and beauty, the new coating cleans easily, can be washed repeatedly, and

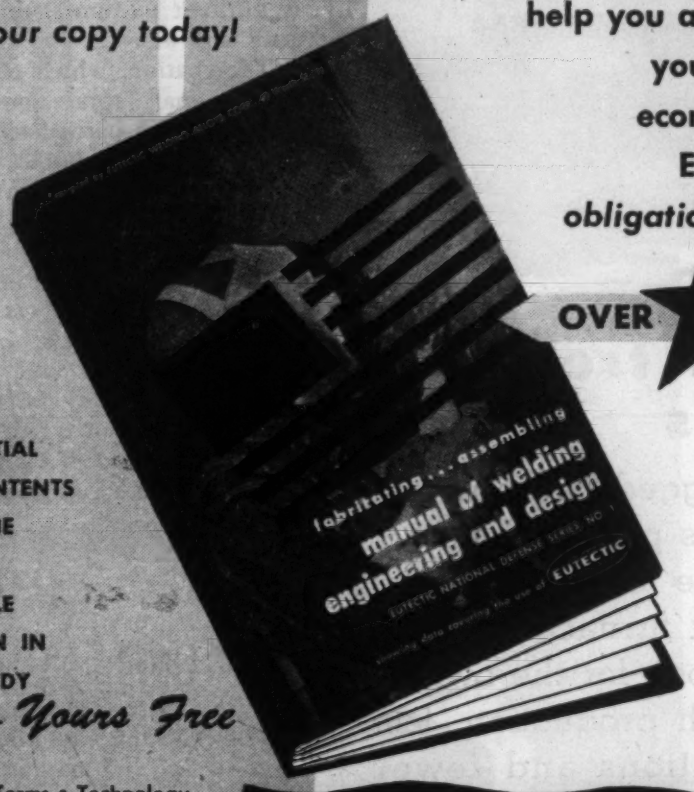
yours free!

Send for your copy today!

new welding design manual

new data . . . accurate . . . reliable . . . complete!

To assist you in your re-tooling problems . . . or to help you analyze your present welding methods so that you may enjoy maximum speed, efficiency, and economy in many of YOUR production problems, EUTECTIC offers — *FREE of charge and without obligation* — this new, packed-full-ofinformation book!



OVER 40 PAGES • PROFUSELY ILLUSTRATED

Over 40 pages of helpful data covering basic and advanced welding techniques and designs used in fabricating and assembly. Profusely illustrated with scores of application drawings, weld diagrams, how-to-do-it sketches, etc. In addition, you will find page after page of tables containing latest information on melting temperatures, tensile strengths, corrosion factors, nomenclature, alloy recommendations, etc. Convenient digest size.

THIS PARTIAL LIST OF CONTENTS SHOWS THE WEALTH OF VALUABLE INFORMATION IN THIS HANDY MANUAL— *Yours Free*

Definition of Terms • Technology Temperatures of application • Joining Methods: Torch Joining; Arc Joining; Induction Joining; Furnace Joining; Inert Arc Joining • Recommendations of Types of Joint and Heating Methods • Design Information: Square Butt Joint; Lap Joint; Flange Joint; Beveled Butt Joint; Fillet Weld; Overlay • Fluxing and Removal of Flux • Inspection and Control • Heat-treating of Welded Parts, and Welding of Heat-treated Parts.

—AND SCORES MORE . . . INCLUDING sketches and data on welding alloys for use with: cast iron, all steels, stainless steel, copper, brass, bronze, nickel and its alloys, magnesium, aluminum, hard and machinable overlays, etc., etc., etc.!

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This just-off-the-press book is "must" reading for anyone engaged in defense production and design, and will certainly be time profitably spent for any production man.

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HOW 10 years of EUTECTIC'S continuing welding research have evolved radically new metal joining techniques and designs.

WHY over 67,000 plants throughout America specify genuine "EUTECTIC" for all their welding alloy needs.

WHICH of your present designs can be altered to take advantage of these new production methods.

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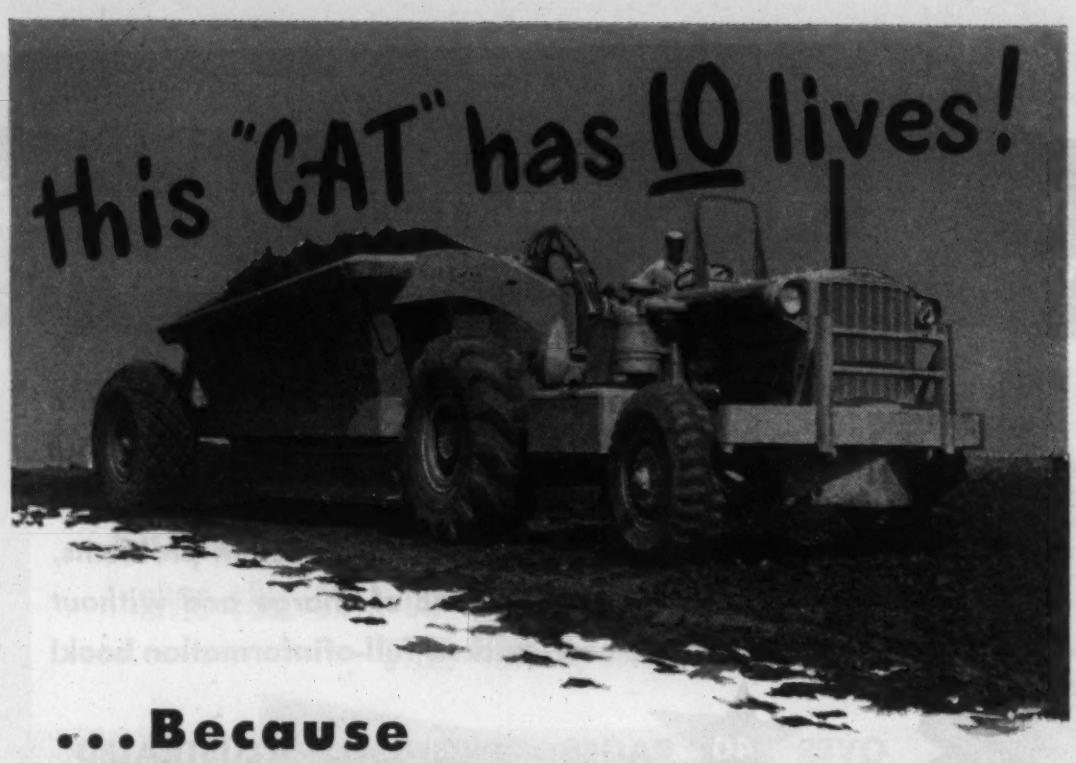
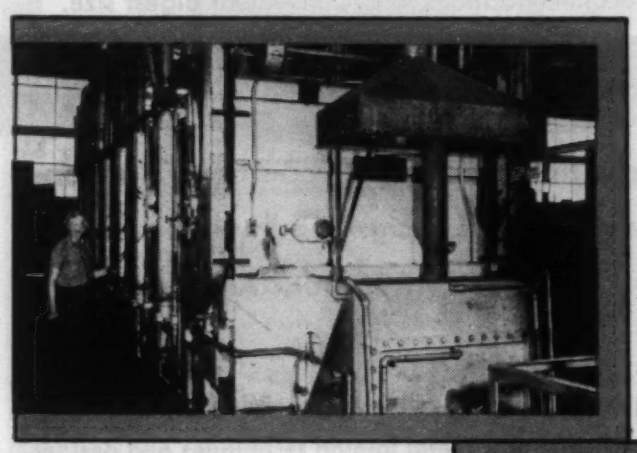


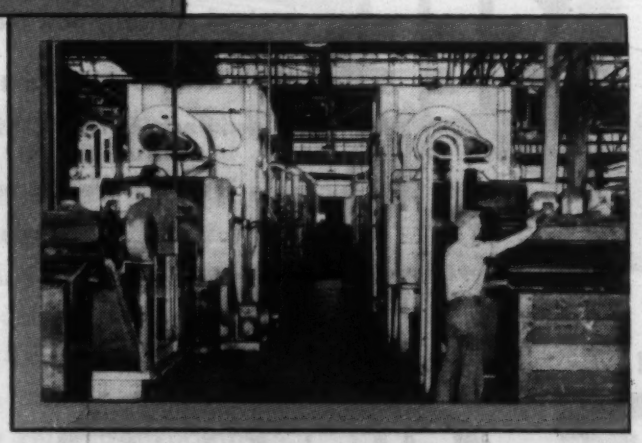
...Because critical parts are heat treated in HOLCROFT furnaces

Caterpillar Tractor Co.—producer of rugged, long-lasting earthmovers—adds another life to the cat's proverbial nine! This new model will last longer because certain critical parts are hardened and drawn in Holcroft furnaces. Result: extra stamina for the product and lower costs for the owner. Plant savings are possible because of high production, fast operations and fewer rejects.



This is the discharge end of one of two Holcroft hardening furnaces in the "Caterpillar" plant. It is radiant-tube-fired, completely conveyorized, and has a capacity of 3000 lbs. per hour.

This is the unloading end of the twin draw furnaces. They are also conveyorized, using alloy roller chains. The furnace is heated by gas-fired recirculating heaters.



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New Materials and Equipment

is resistant to fumes, mildew, and to most acids and alkalies.

The coating, which can be applied with conventional spray gun equipment, is claimed to be particularly suitable for protection of homes, hotels, motor courts, hospitals and schools, as well as all types of commercial buildings. Available in flat, semi-lustre, and glass finishes, it is produced in any desired color and can be used on such building surfaces as wood, masonry, brick, stucco, metals, concrete and rock board.

Other advantages claimed for the coating are that it dries in 5 to 10 min., withstands temperatures to 160 F, requires little thinning, and is non-inflammable and odorless when dry.

Plastic Finish

A clear, fast-drying plastic synthetic finish, Base VC-38, designed particularly for use on trim and hardware made of brass and other metals, has been developed by *United Lacquer Mfg. Corp.*, 1001 W. Elizabeth Ave., Linden, N. J.

In addition to brass, the new vinyl finish can be used with good results on iron, copper, gold, cadmium, chromium and nickel, according to the manufacturer. It can also be tinted to give a gold or brass appearance to steel or aluminum.

Chief advantage claimed for the finish is its fast drying time. It will air dry sufficiently to handle in 30 min. and will become hard overnight. When baked in a gas oven at between 200 and 250 F or under infra-red lights, it will dry hard in 10 min. Field tests are said to have shown that Base VC-38 gives metal products durability and resistance to perspiration, handling, marring and tarnish. In addition, it has good adhesion and excellent hiding and flowing qualities.

The new finish is available in either a satin or flat finish, and can be applied by dipping or spraying.

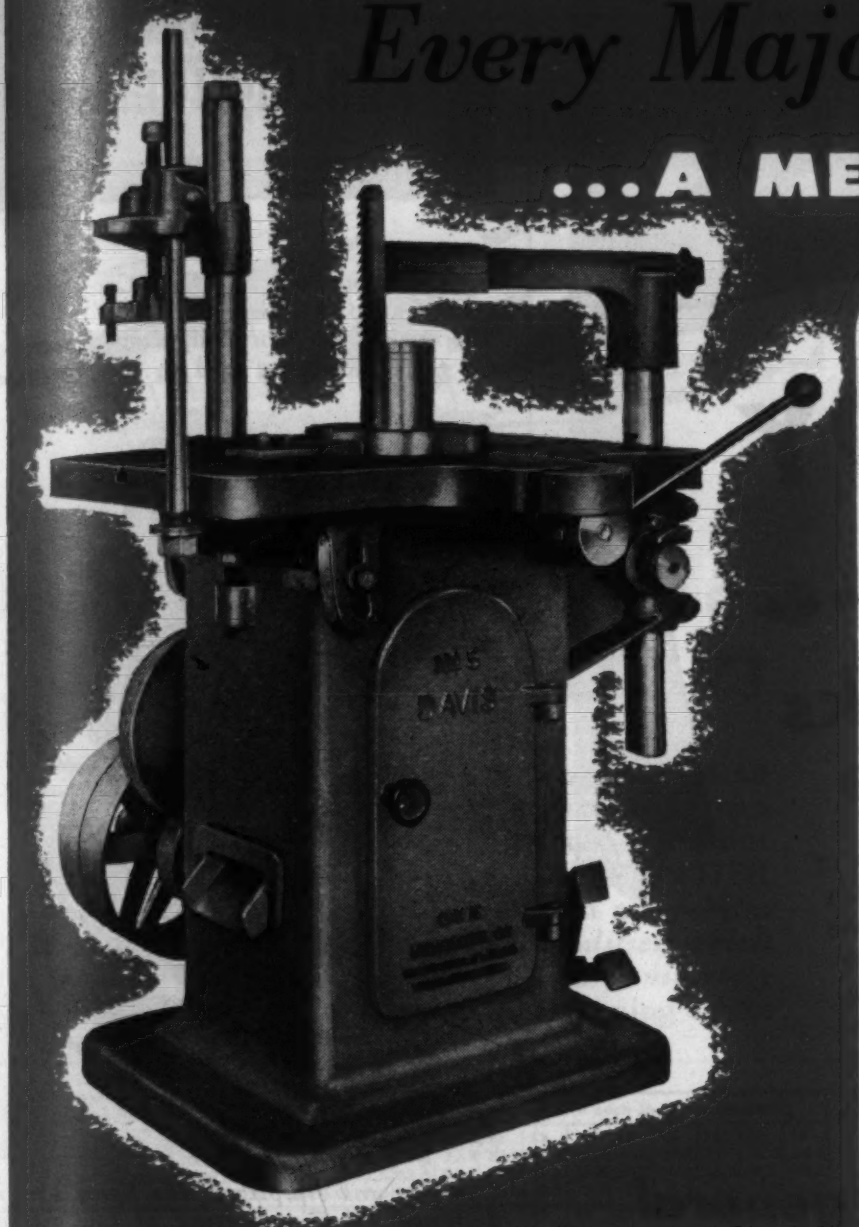
Cleaning & Finishing

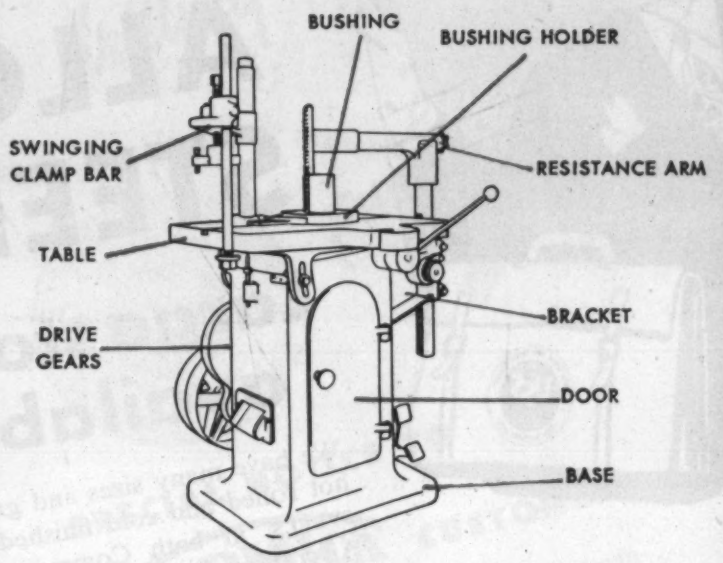
Spray Gun

Development of a compact, simplified spray gun designed specifically for the spraying of low melting alloys and metals has

Every Major Component—

...A MEEHANITE® CASTING





Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

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The American Laundry Machinery Co. ..... Rochester, New York
Atlas Foundry Co. ..... Detroit, Michigan
Banner Iron Works ..... St. Louis, Missouri
Barnett Foundry & Machine Co. ..... Irvington, New Jersey
E. W. Bliss Co. ..... Hastings, Mich. and Toledo, O.
Builders Iron Foundry ..... Providence, Rhode Island
Continental Gin Co. ..... Birmingham, Alabama
Crawford & Doherty Foundry Co. ..... Portland, Oregon
The Cooper-Bessemer Corp. ..... Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc. ..... Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. ..... Florence, New Jersey
Fulton Foundry & Machine Co., Inc. ..... Cleveland, Ohio
General Foundry & Manufacturing Co. ..... Flint, Michigan
Greenlee Foundry Co. ..... Chicago, Illinois
The Hamilton Foundry & Machine Co. ..... Hamilton, Ohio
Johnstone Foundries, Inc. ..... Grove City, Pennsylvania
Kanawha Manufacturing Co. ..... Charleston, West Virginia
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Lincoln Foundry Corp. ..... Los Angeles, California
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The Henry Perkins Co. ..... Bridgewater, Massachusetts
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Rosedale Foundry & Machine Co. ..... Pittsburgh, Pennsylvania
Ross-Meehan Foundries ..... Chattanooga, Tennessee
Shenango-Penn Mold Co. ..... Dover, Ohio
Sonith Industries, Inc. ..... Indianapolis, Ind.
Standard Foundry Co. ..... Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. ..... Denver, Colorado
Traylor Engineering & Mfg. Co. ..... Allentown, Pennsylvania
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Vulcan Foundry Co. ..... Oakland, California
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"This advertisement sponsored by foundries listed above."

MEEHANITE®

New Rochelle, N. Y.

The Davis Keyseater, manufactured by Davis Keyseater Company, Rochester, N. Y. is another example of precision production equipment built almost entirely with Meehanite castings.

As the illustration indicates every major component is a Meehanite casting from drive gears to base. Designers, production engineers, management and purchasing officials have over the years come to recognize that Meehanite castings provide them with certain characteristics which in today's industrial picture are "musts." These are:

1. Dependable design characteristics with a high degree of superiority.
2. Day by day uniformity and soundness.
3. Economy through regular machinability and higher freedom from defects.

Analyze your design and casting problems or requirements. Take advantage of the basic metallurgical fact that "Meehanite Bridges the Gap between Cast Iron and Steel®", combining the better properties of both. Ask any of the Meehanite foundries listed below for the Meehanite Handbook, 67 pages of engineering information.

News about steel

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Large stocks available

We have many sizes and grades of hot rolled and cold finished ALLOY STEELS, in both Commercial and Aircraft qualities, available for immediate delivery. Stocks are large, so there is reasonably good assurance that we will be able to provide an ALLOY STEEL that meets your requirements.

WAREHOUSE STOCKS...*in general*

The demand for steel has stepped up to such an extent that it has become increasingly difficult to supply all the steel our customers request. Critical items are being allocated in the fairest way possible . . . while stocks which have not been severely affected continue to be available for immediate delivery. We welcome your inquiries, and will do our best to supply the steel you need.

A TIMELY SERVICE

During the current period of steel shortages, you may occasionally be confronted with the necessity of finding a substitute steel for one which you have used in the past. If this should happen, remember that our sales and metallurgical staffs have had considerable experience with all types of steels, and they will be happy to work with you in finding an acceptable substitute.

WHEN YOU DEAL WITH US, YOU GET Service Plus!

UNITED STATES STEEL SUPPLY COMPANY

USS

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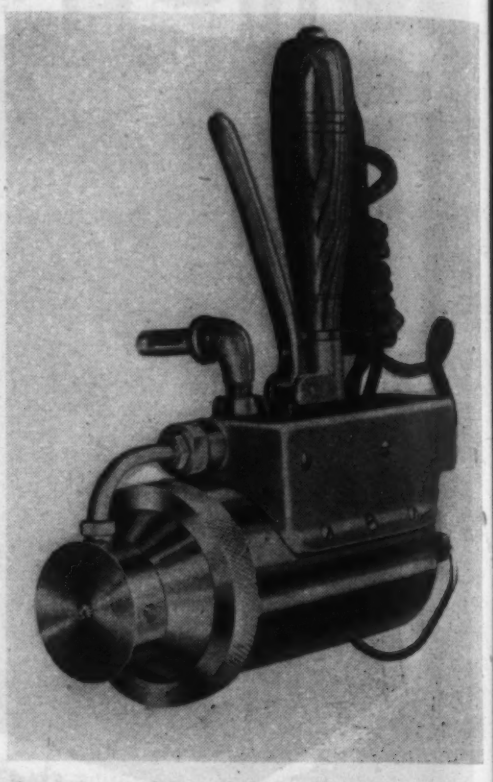
UNITED STATES STEEL

New Materials and Equipment

been announced by *The Cooper Alloy Foundry Co.*, Hillsdale, N. J.

Some of the more important features of the Spray King are said to include adjustable spray, non-clog non-drip nozzle, thermostatic control, light weight (less than 5 lb.), large capacity (7 lb. of low-melting alloy), simplicity of operation, and low cost.



Compact and simplified, the Spray King is designed for the spraying of low melting metals and alloys.

Suitable for intermittent or production spraying, the Spray King is suitable for use by patternmakers, rectifier manufacturers, dental supply houses, precision casting companies, tool and die divisions, and maintenance and repair men.

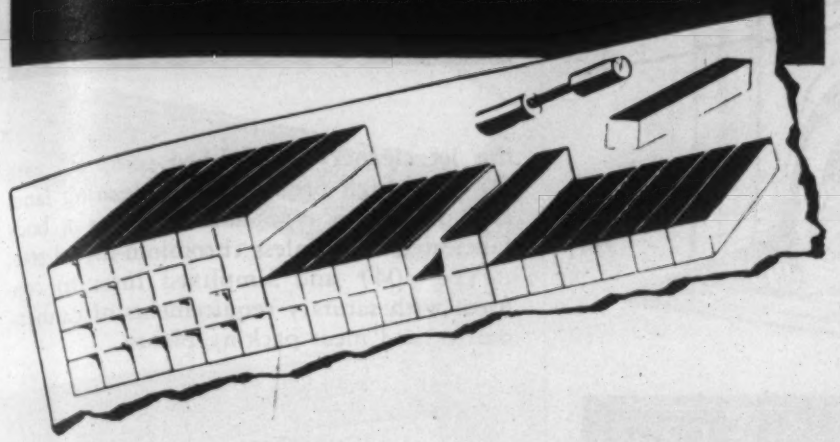
Jet Cleaner

A new, high pressure jet cleaner for daily clean up of food plants and processing equipment has been announced by *Sellers Injector Corp.*, 1636 Hamilton St., Philadelphia 30.

Delivering a high volume, high pressure jet of hot water, mixed with a detergent or solvent if desired, the Hi-Pressure jet cleaner effectively cleans all types of surfaces. Dirt, slime and grease, which previously could be removed only by considerable hand scrubbing or scraping, are said to be easily washed away by the machine. The jet cleaner has no moving parts and requires only connection to steam and cold water lines, yet it will deliver an effective hot water jet adjustable from 115 to 205 F at 50 to 310 psi.

Able to double the supply steam pressure,

If You Want the Quality of the TEST BAR in Your Castings!



Specify FRONTIER 40-E ALUMINUM ALLOY!

● Ordinarily the physical properties of an aluminum-alloy casting are less than those of a separately-cast test bar. But because of the special qualities of FRONTIER 40-E—the *non-heat-treated* aluminum alloy—you can be sure that *the same high qualities which show up in the test bar will appear uniformly throughout a large casting.* The following tables tell the story:

40-E Step Block Casting Cut Into 42 Test Bars—Physical Properties of each Shown in Squares.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Y.S.	22.5	20.0	21.2	20.6	20.5	22.0	20.8	21.0	21.8	22.5	23.0	23.4	23.0	25.0	23 8	22 5	23 5	24.6
T.S.	38.3	33.0	33.1	32.7	33.8	36.0	33.8	32.5	33.5	34.5	34.0	37 2	37.8	39.0	36 8	36 5	36.7	40.0
El.	12.5	10.0	6.0	4.0	7.5	7.5	8.0	7.0	7.0	7.5	7 0	8.0	8.5	8 5	7 5	8.0	7 5	10.0

	30	29	28	27	26	25	24	23	22	21	20	19
Y.S.	22.0	23.0	22.5	21 5	22 5	23.5	22.5	43 5	23 5	23 8	22.8	23.8
T.S.	36.3	35.3	35.3	35.0	35.0	37.3	34.5	32.0	32 5	32 5	35.0	38.3
El.	10.0	6.0	9.0	7 5	7.5	6.0	5.0	5.0	5.0	5.0	7 5	7.5

	31	32	33	34	35	36
Y.S.	23.0	22 8	22 5	24.0	23 5	23.0
T.S.	36.3	33.3	32 5	32.5	36.3	39.0
El.	8.0	5.0	5 0	5.0	7.0	8.5

	42	41	40	39	38	37
Y.S.	23.3	23.7	23.0	23.2	23.0	22.5
T.S.	33.2	37 1	36.4	37 3	38.0	40.8
El.	3.0	8.0	6.5	6.5	11.0	11.0

Separately-Cast Test Bar Properties		
NAT. AGED 21 DAYS	Y.S.	23500
	T.S.	36600
	El.	7.5

PROPERTIES OF CASTING (BASED ON TENSILE STRENGTH READINGS)			
	Maximum	Minimum	Average
Y.S.	22,500	22,500	22,700
T.S.	40,800	32,500	35,500
El.	11.0	5.0	7.5

Write TODAY for full details about Frontier 40-E Aluminum Alloy . . . including FREE DATA BOOK.

40-E Meets these Gov't. Specifications

U.S. Army-Navy Air Corps	AN-A-17
U.S. Navy, Bureau of Aeronautics	AN-A-17
U.S. Navy, Bureau of Ships	46A1F Class I (Int)
A.S.T.M.	B-26-46T-ZG41
S.A.E.	310
U.S. Army Ordnance	AXX-1348

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If you use Formica laminated plastics, be sure to get the additional benefit of Formica's fabricating service. For complete information, send today for new catalog just off the press. Address The Formica Co., 4678 Spring Grove Ave., Cincinnati 32, Ohio

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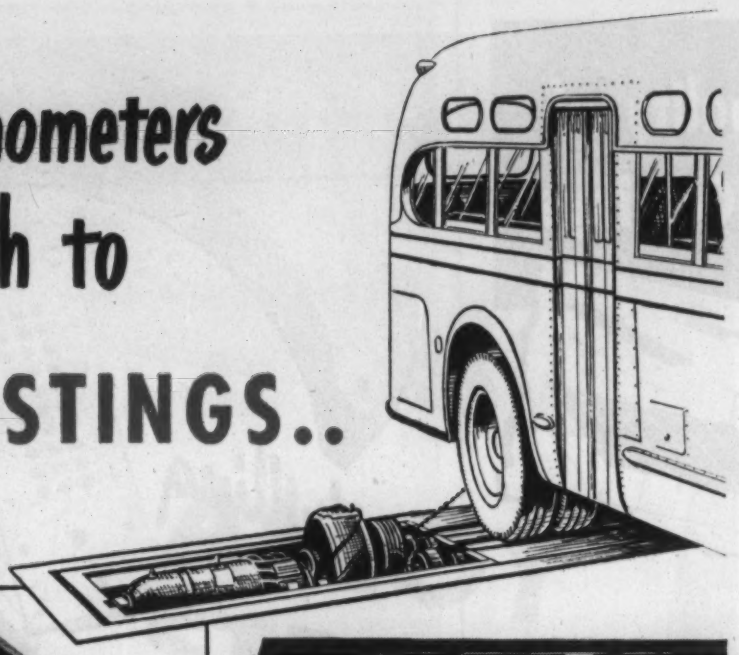
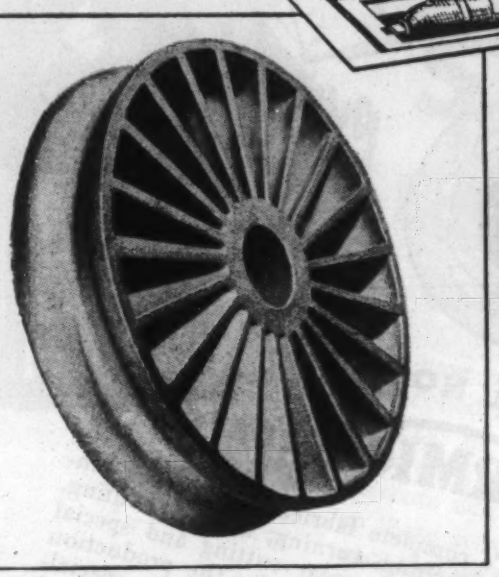
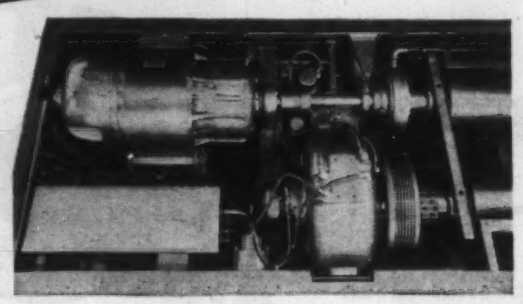
Dynamometers switch to UNITCASTINGS..







with Unitcastings

- GREATER STRENGTH
- LESS BREAKAGE
- GREATER SAFETY

KEEP BUSSES IN TOP RUNNING EFFICIENCY!

This Bennett-Feragen Dynamometer, designed for testing the horsepower of internal combustion engines, helps keep bus transit systems at peak operating efficiency. In actual testing operations, however, parts of the Dynamometer rotate at very high speeds. The illustrated impeller was switched to Unitcastings from other metal products to gain greater strength with less danger of breakage and provide greater testing safety. If your problem concerns special alloys, difficult casts, close tolerances, see what Unitcastings can do to build quality into your product.

UNITCAST *Corporation*
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

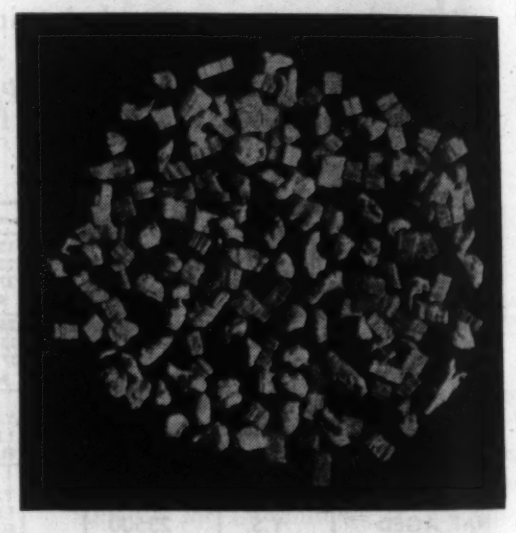
New Materials and Equipment

the jet cleaner is furnished complete with 50 ft. of high pressure hose, cleaning lance and dispersion type nozzle. It has a body fabricated of stainless chromium-nickel steel (Type 304) and simplified lines to conform with sanitary requirements of canners, dairies and meat packing plants.

Barrel Polishing Compound

Korn-Kube, a new barrel polishing medium for all metals, plastics, rubber, wood, glass and other materials, is now available from *Kube-Kut, Inc.*, 625 Midland Ave., Garfield, N. J.

The new medium is composed of dried hardwood (maple) in cube form and macerated corn cobs. Both materials are



This new barrel polishing medium consists of dried hardwood and macerated corn cobs.

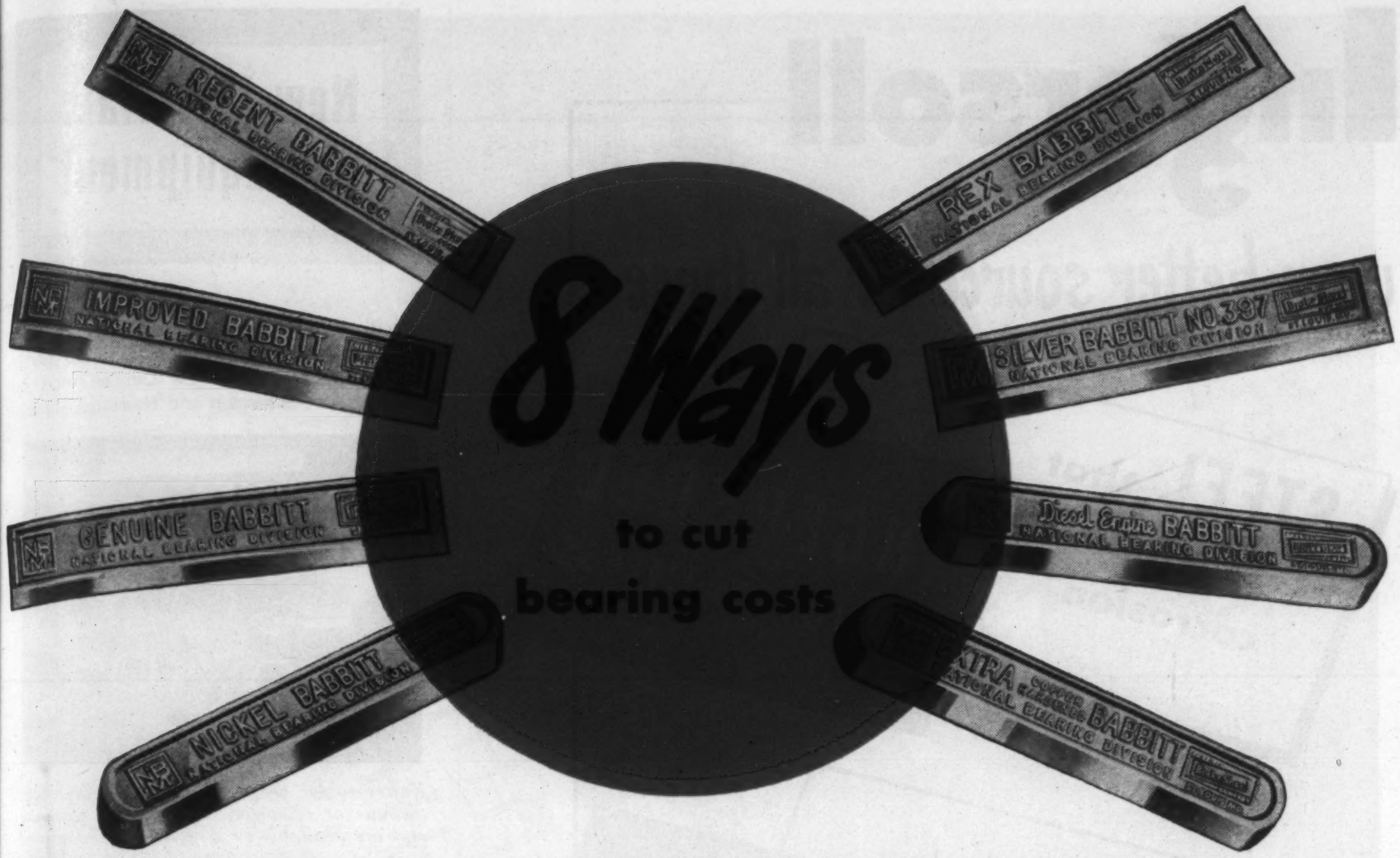
thoroughly screened and aspirated to remove dust, and the mixture combines the high absorption of the sawdust with the tougher polishing action of the pulverized corn cobs. The mixture permits drying and polishing of the materials, regardless of size, just so long as they can be handled by tumbling barrels in a minimum of time and at low cost.

A variety of mixtures and particle sizes are available to meet specific conditions.

Welding & Joining

Solder Preforms

Solder preformed in rings, pellets, washers, and unusual shapes and sizes to



The complete N-B-M BABBITT line . . . with each babbitt alloyed for specific service . . . gives you lower cost bearing life.

So-called "all-purpose" babbitts may be costing you money. A recent survey of a plant made by one of our engineers proved that a *saving of one-third on babbitt costs* could be made by using two grades of babbitt. Instead of using a high-tin babbitt exclusively in this plant, it was found that a very large percentage of the applications required only a low-cost lead-base babbitt.

Whatever your problem in babbitt metal may be, you'll find your answer in the complete line of National Bearing Division. Service recommendations are based on years of successful applications and experiences in solving babbitt problems. Write today for the facts on this complete line of Babbitt Metal.

This free book shows you how to get longer bearing service . . .

Contains valuable and complete data: how to specify, melt and pour Babbitt . . . how to prepare shells for stronger bonds. Use the handy coupon to order your free copy today.

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STEEL that resists corrosion

INGERSOLL SOLID STAINLESS

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STEEL that gives stainless protection at lower cost

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BORG-WARNER CORPORATION

310 South Michigan Avenue • Chicago 4, Illinois

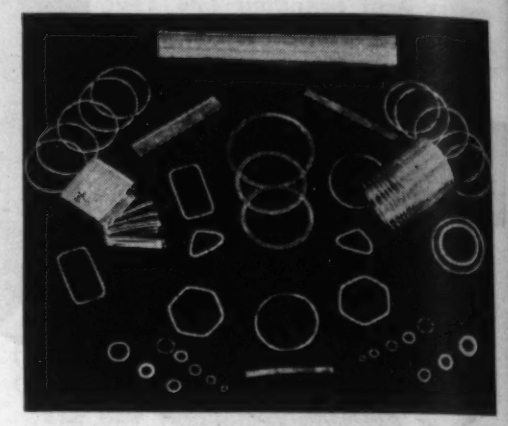
Plants: Chicago, Illinois, New Castle, Indiana, and Kalamazoo, Michigan

ENGINEERING B-W PRODUCTION

New Materials and Equipment

specifications is available from *Kester Solder Co.*, 4201 Wrightwood Ave., Chicago 39.

These solder preforms can be used in flame, oven, induction and resistance solder-



Kester solder preforms are used where continuous or repetitive soldering is required, and are available in a variety of shapes and sizes.

ing to assure uniform results where continuous or repetitive soldering is required.

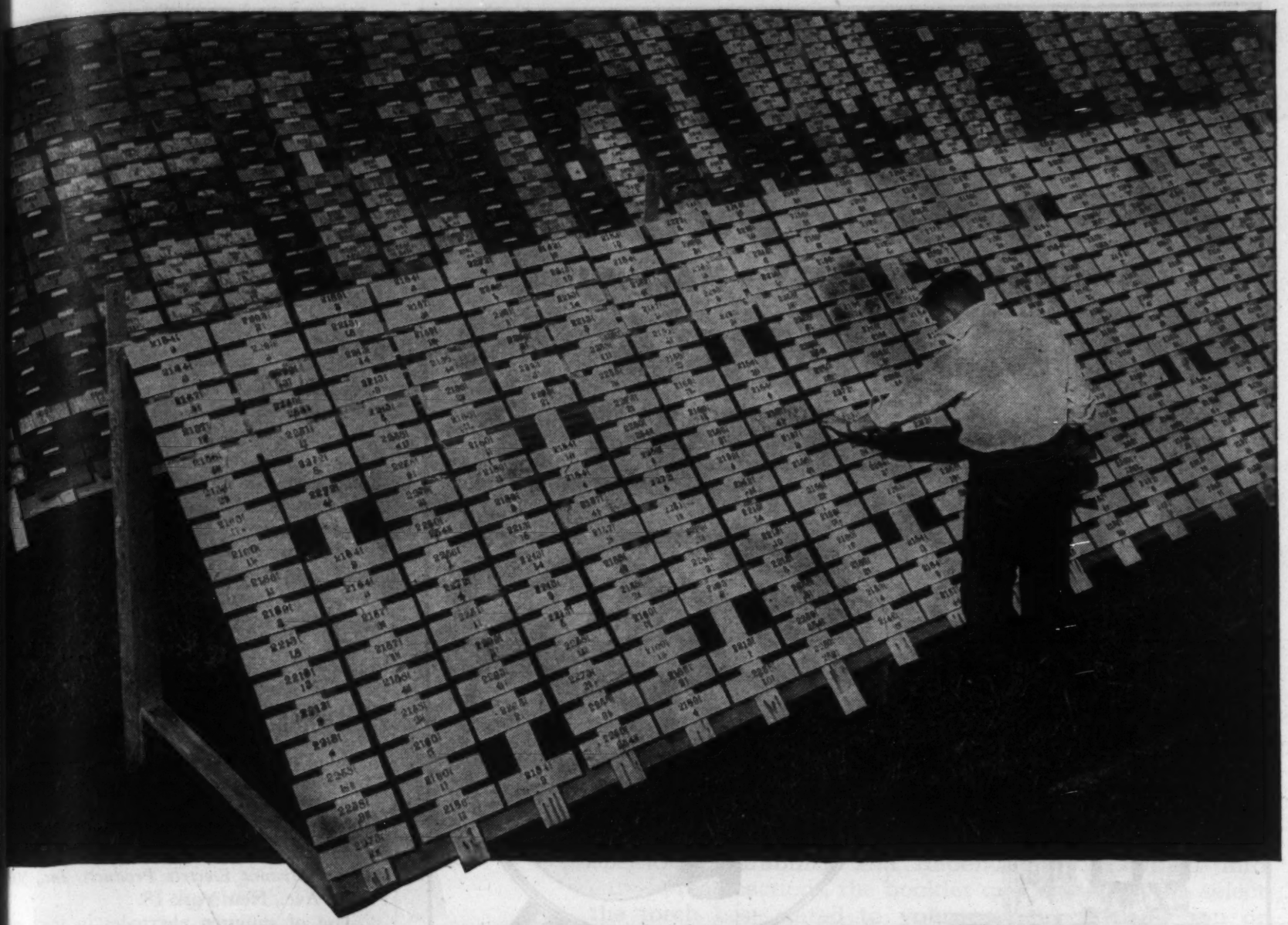
Use of the preforms is said to eliminate solder waste, save on labor costs, and reduce rejects.

Welding Power Units

Development of two special power units, designed for use with Nelson stud welding equipment, has been announced by *Morton Gregory Corp.*, Lorain, Ohio.

One unit is a motor-operated generator set capable of welding studs up to and including 5/8-in. dia. It is said to be superior to 600-amp. generators now available and equivalent to two conventional 400-amp. generators in parallel, although its cost is approximately one-third less than that of the two units. In addition, the compact generator set is comparable in size to a 200-amp. welding generator and weighs ap-

This Nelson motor-operated generator is designed especially for stud welding of fasteners up to 5/8-in. dia.



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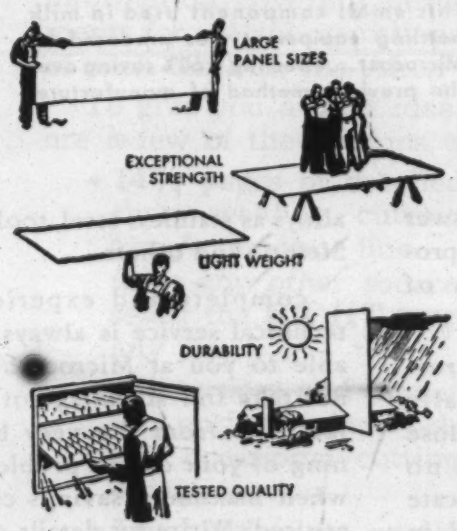
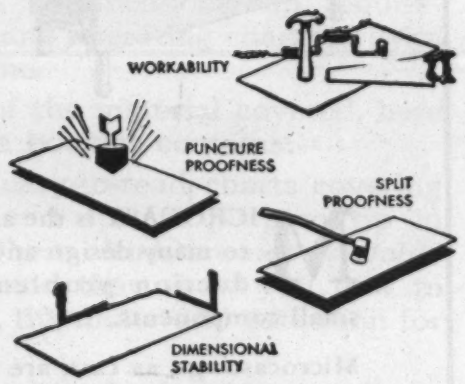
Such "torture" tests are in addition to rigid laboratory testing of current production under U. S. Commercial Standard CS45-48. Douglas fir plywood *must* constantly prove its quality—another reason why this "real wood of 1,000 uses" can help you solve many a production, construction, maintenance and container problem.





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For information write: Douglas Fir Plywood Association, Tacoma Building, Tacoma 2, Washington; Field Offices—848 Daily News Building, Chicago 6; 1232 Shoreham Building, Washington 5, D. C.; 500 Fifth Avenue, New York City 18.

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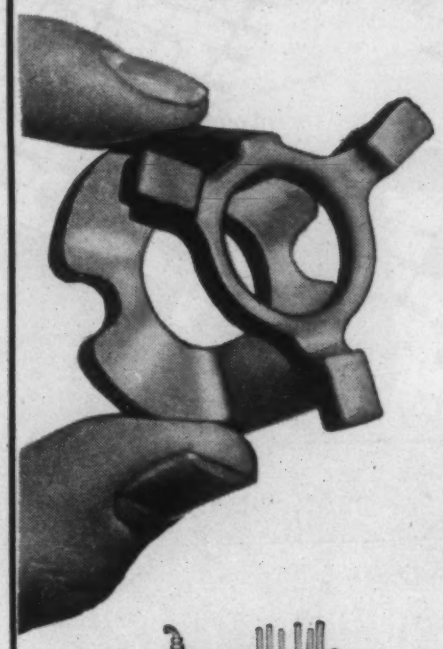

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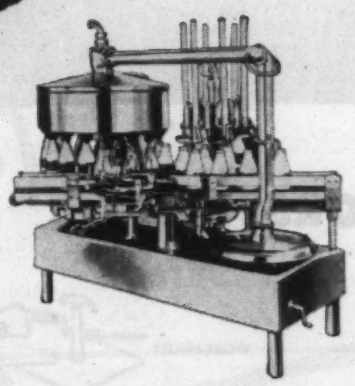

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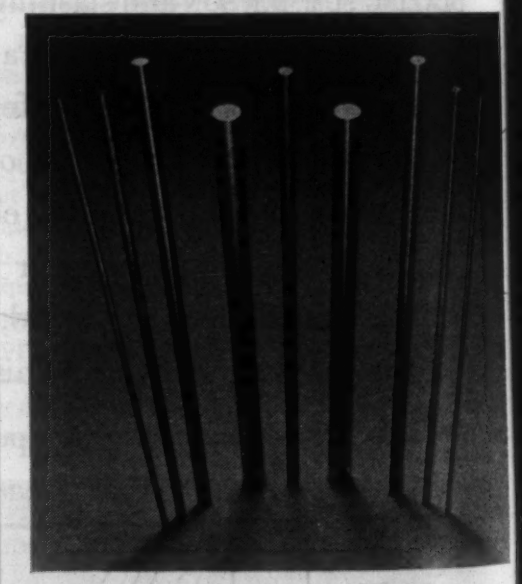
proximately 800 lb. It can be powered with either 220- or 440-v., 60-cycle a.c. current.

Wherever the voltages required for the operation of generators is not available, the new battery unit, requiring only a 110-v. a.c. outlet, is said to be a reliable source of power for stud welding. This unit consists of twelve 6-v., 150-amp. wet storage batteries mounted on a strong frame and covered with a hood on which an automatic battery charging device is fastened. The entire unit weighs approximately 1100 lb. and, when used on construction work, can be conveniently moved on a trailer or pick-up truck.

Tungsten Electrodes

Pure tungsten electrodes having a melting point about 6000 F and suitable for atomic hydrogen and gas shielded electric arc welding of a wide range of metals are now being produced by the *Tungsten and Chemical Div., Sylvania Electric Products, Inc.*, 500 Fifth Ave., New York 18.

Use of tungsten electrodes in inert gas atmospheres, according to the manufacturer, prevents the formation of oxides, nitrides and other contaminants which tend to reduce the strength of welds. Since tungsten



Pure tungsten electrodes with a melting point of 6000 F are now available to industry.

has the lowest vapor pressure property of any metal, the amount of electrode consumed in the welding process is held at a minimum.

Inert gas atmosphere welding also permits faster operation, narrower heat-affected sections, less distortion, elimination of flux, improved visibility of weld pool, close control of better quality welds, improved appearance of joints, and frequent elimination of filler metal when thin sections are joined. The process is said to be applicable to the

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To give you a brief idea of the material covered, here are a few of the sections the booklet contains:

- 14½ pages of detailed easy-to-read charts covering every welding, cutting and special purpose tip in Airco's complete line . . . *these charts are not available from any other source,* and they show you how to select the **RIGHT** torch, tip, mixer and extension for any job.
- All-purpose and moderately priced welding and cutting outfits for heavy-duty or light day-to-day welding and occasional cutting are shown in an illustrated 4-page section.
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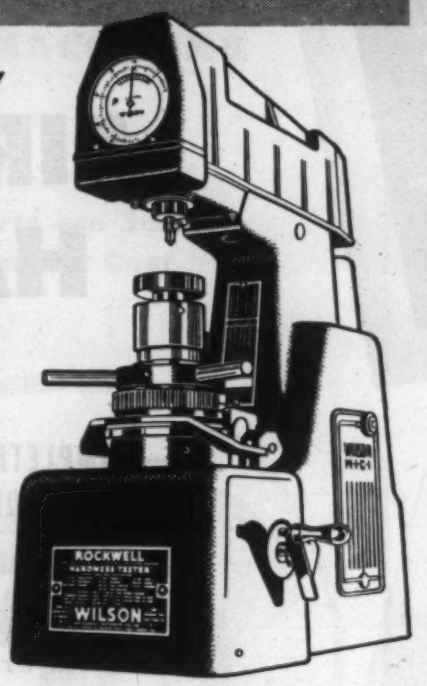

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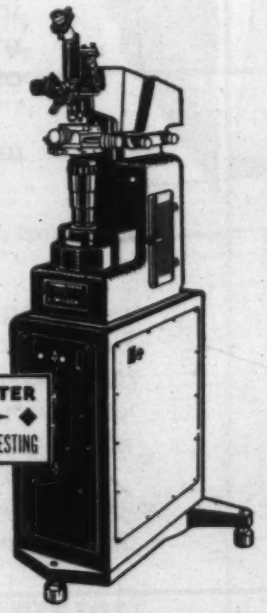

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Used in proper welding conditions, the electrodes are said to resist the extreme heat of the arc; retain stiffness; keep the arc properly spaced; and are consumed at an almost imperceptible rate. They are available in any diameter and length.

•

Forming & Machining

Hand Power Tool

Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago 7, has developed the Handee 85, a new hand power tool for precision work. Balanced and shaped to fit the hand, the Handee 85 has an idling speed of

Balanced and shaped to fit the hand, the Handee 85 has an idling speed of 27,000 rpm. and a load speed of 20,000 rpm.

27,000 rpm. and a load speed of 20,000 rpm. It weighs 2 lb. and chucks interchangeable spring collets of 1/16-, 3/32- and 1/8-in. capacity. The chuck construction is said to assure smooth running action with a quick, firm grip on all accessories. An air-cooled design permits the hand tool to be operated all day without overheating.

A unique feature of the Handee 85 is a cast-in boss, just behind the chuck, which

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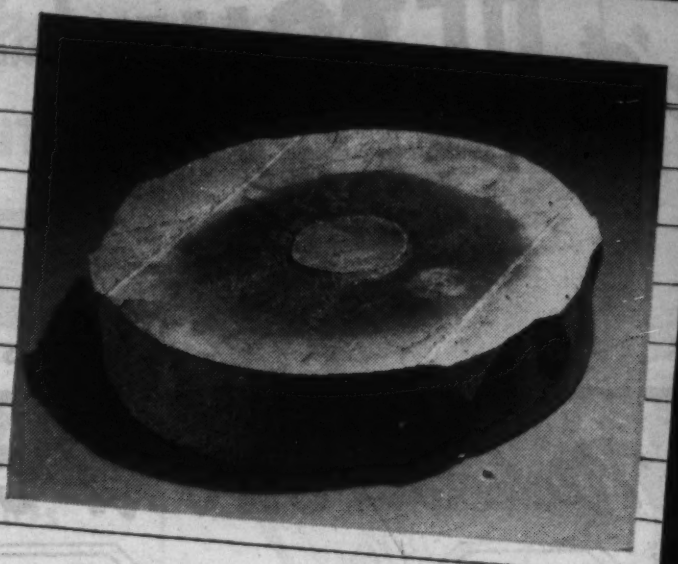
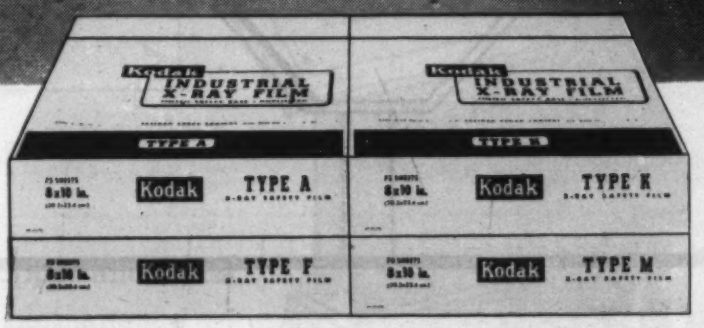
Product:
Cast part for vital aircraft pump
Material:
Aluminum, 2¼" thick, 11¼" diameter
Equipment:
150kv x-ray unit



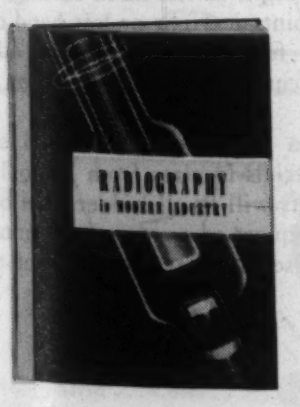
ANSWER:



KODAK INDUSTRIAL X-RAY FILM, TYPE A

With time, money and safety at stake, radiography was used to check this important casting for defects. With moderate kilovoltage to work with, and with aluminum as the material, the radiographer selected Kodak Industrial X-ray Film, Type A.

For with light alloys, this film has enough speed to keep exposures reasonably short even at low voltages. Its high contrast and fine graininess also permit taking full advantage of high kilovoltage machines in detecting irregularities in thick dense materials.



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Type A—has high contrast with time-saving speed for study of light alloys at low voltage and for examining heavy parts at 1000kv. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, under direct exposure or with lead-foil screens. It has extra-fine grain and, though speed is less than in Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays, exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

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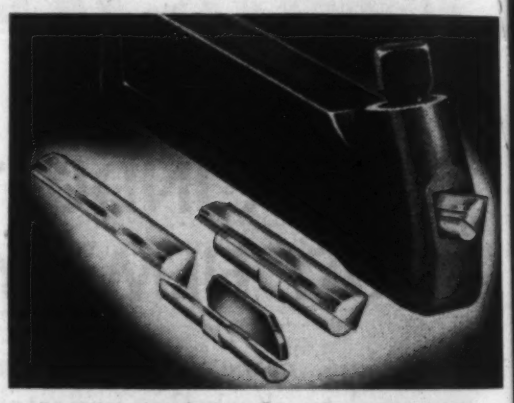
New Materials and Equipment

holds easily attached routing and molding shoes, making it possible for 20 different molding cuts to be made.

Although some 200 different accessories are available for use with the Handee 85, according to the manufacturer, 41 matched attachments have been assembled together with the tool in a steel-gray fitted metal case. The combination is called the Handee Workshop.

New Cutting Tool

A tool bit having two cutting sides and chip-breakers the full length of the bit and which allows any desired side clearance or side rake angle has been developed by *Speed Bits*, 3776 W. 152 St., Cleveland 11.



This wedge-shaped tool bit has two cutting sides, but will lock into any standard tool holder.

Another advantage of the new tool bit is a self-seating and locking feature which locks it to all four sides of the square or rectangular channel in the Armstrong, Williams, or other standard tool holders and boring bars.

Variations of the front clearance and end cutting edge angle permits the same tool bit to be used for right or left hand cutting, for two cutting points in right or left hand cutting, one end for roughing and the other for finishing cuts, or any combination of these.

Available in high-speed tool steel and cast alloy materials in sizes from 1/8 to 1 1/8 in., the tool bits will fit all holders and boring bars with square or rectangular channels and having a set screw on the top of the channel.

Lead Press

A lead press of new and unique design has been placed in operation by *New England Lead Burning Co.*, 4975 Tyler Ave., St. Louis, Mo.

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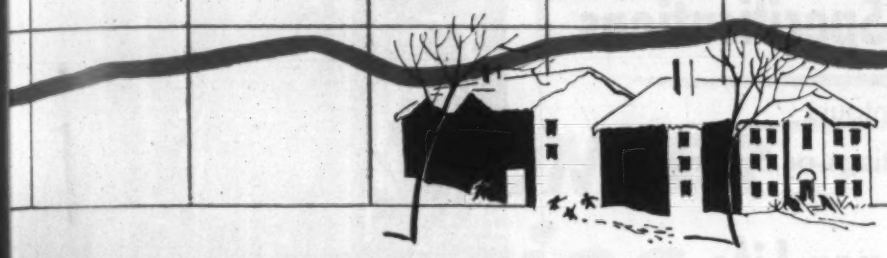

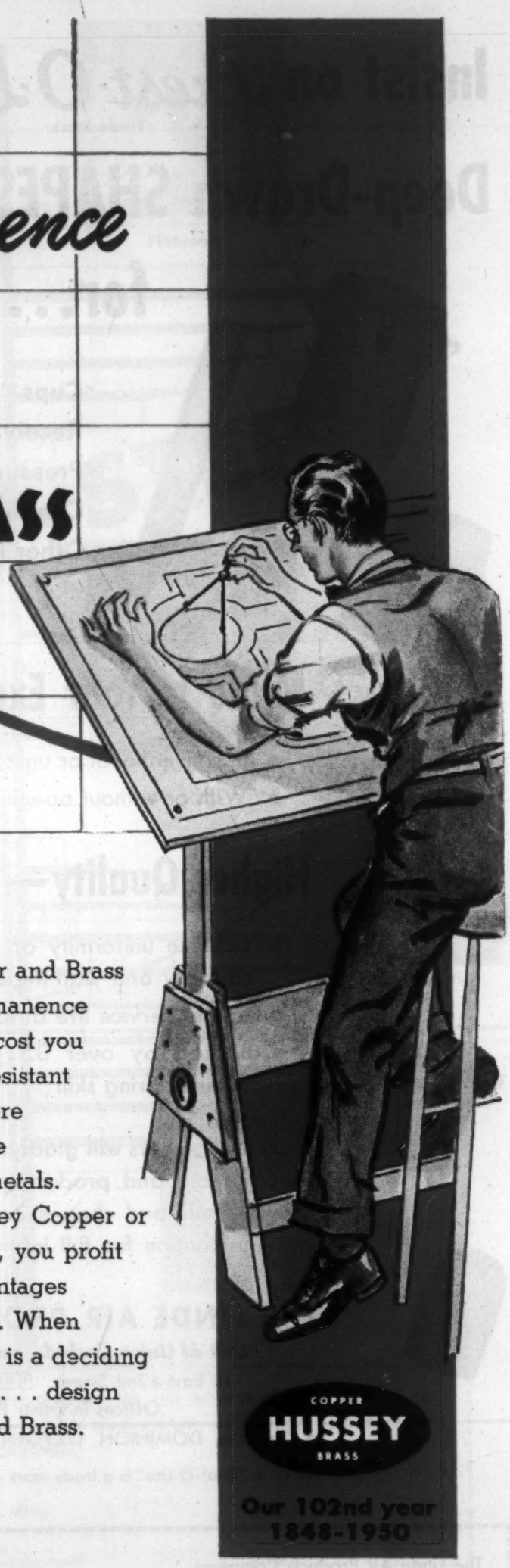

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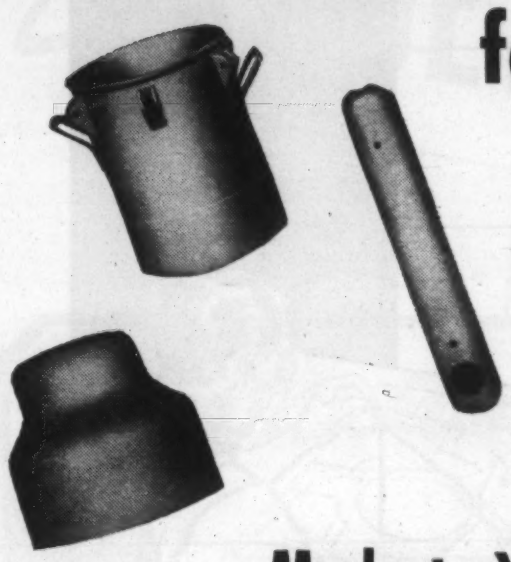

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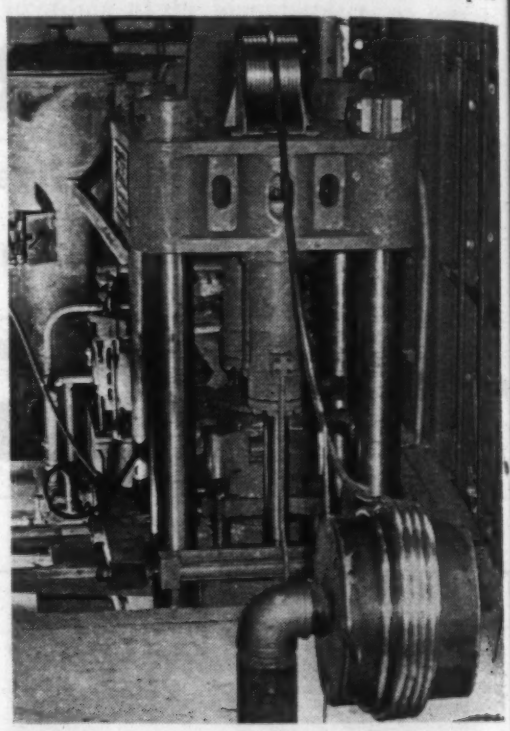


This new lead press was recently placed in operation by the New England Lead Burning Co.

(2) A compact self-contained hydraulic pump unit which makes extra space or basement area for the pump units unnecessary.

(3) The press is built to extrude under 1000 lb. of hydraulic pressure and can extrude any item from wire solder, all sizes of tubing, plumbers lead pipe, or heavy wall lead pipe for chemical plant installations up to and including 10-in. seamless pipe with ½-in. wall thickness.

Testing & Control

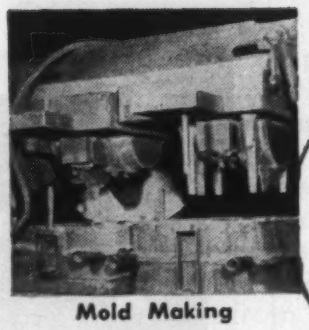
Carbon Detector

Burrell Corp., 1942 Fifth Ave., Pittsburgh, Pa., has developed a new electronic instrument for rapid and accurate determination of carbon by combustion.

The Burrell Combustron is a compact, bench-mounted, self-contained instrument, fully equipped and ready to plug into the power supply. Employing induction heating,

Planning

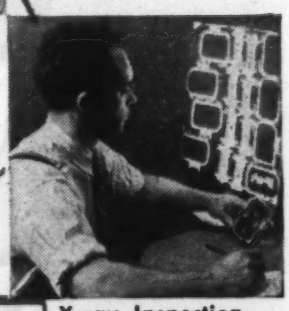
Pattern Making



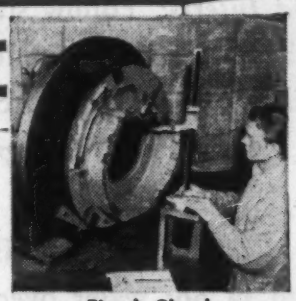
Mold Making

STEP-BY-STEP

Pouring



X-ray Inspection



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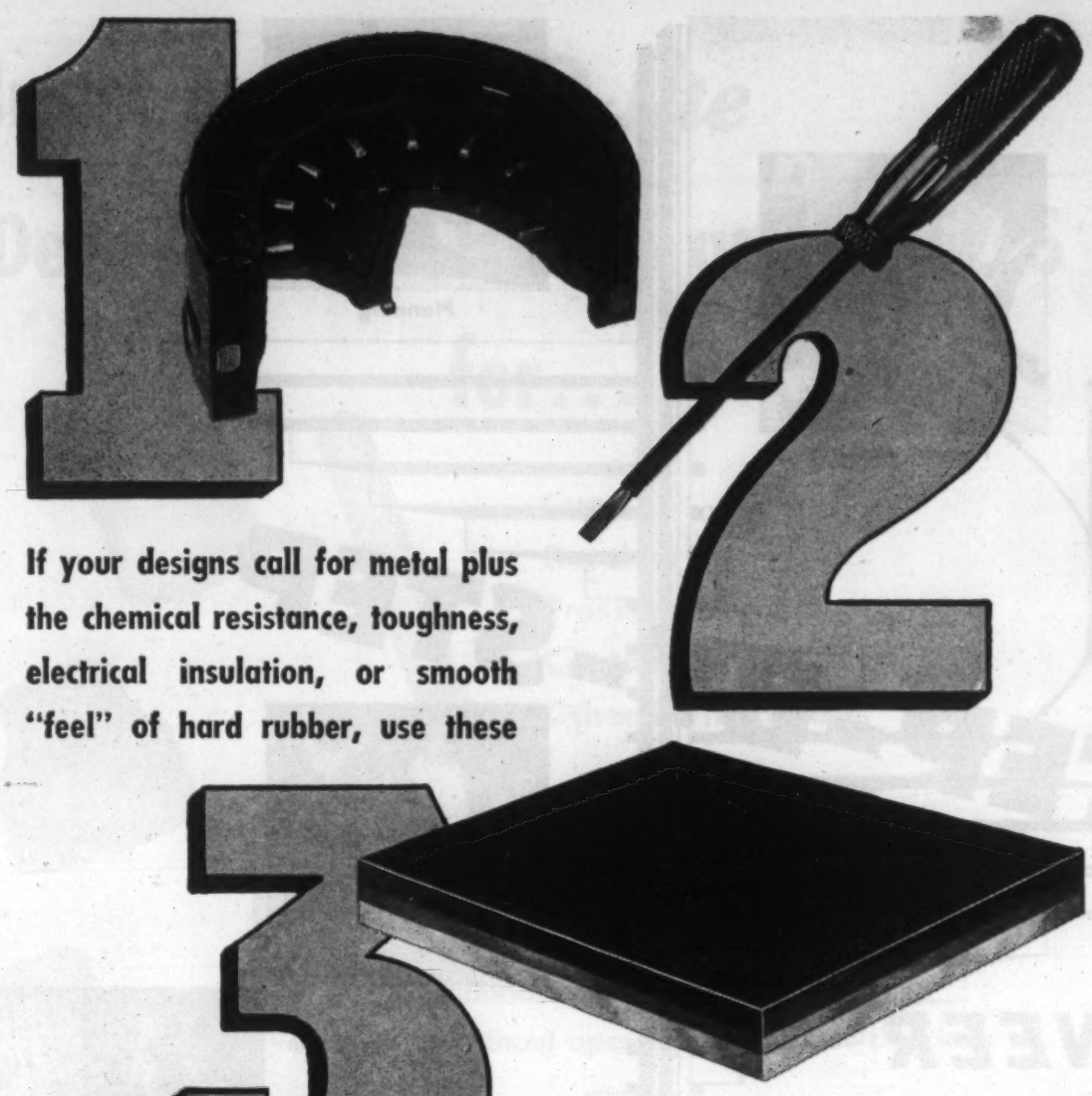


If your designs call for metal plus the chemical resistance, toughness, electrical insulation, or smooth "feel" of hard rubber, use these

3 WAYS TO COMBINE HARD RUBBER AND METAL

1. *Molded Inserts:* Follow standard molding design practice. Magneto part above is good example. Seventeen inserts are molded into high dielectric Magnon Super Ace compound (dielectric strength 600 v/mil at 60 cycles). This Ace grade gives durable strength up to 300°F.

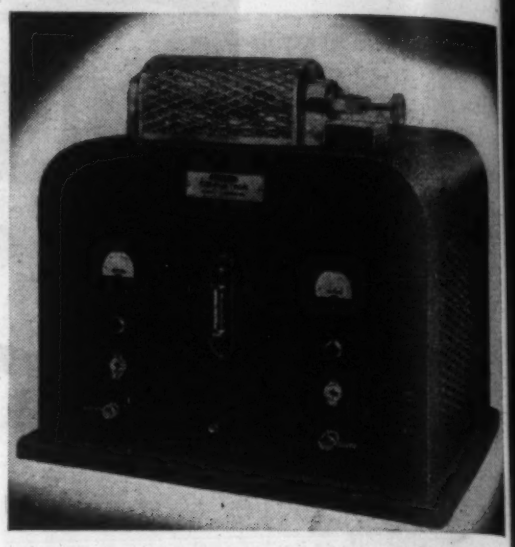
2. *Shrink Fits:* Screwdriver is insulated by slipping hard rubber tube softened in hot water over shank, then slipping heat-softened hard rubber handle over both shank and tube. Rubber cools, shrinks, gives positive-grip, insulated tool as no other material can do. An idea for you?

3. *Vulcanized Cement Bond:* Two-layer process: Hard rubber outer layer for best resistance to chemicals and aging; live, soft-rubber inner layer provides resilience. These Ace linings also can be all-hard or all-soft rubber, natural or synthetic.

Ask for ACE Handbook, a gold mine of helpful information

ACE AMERICAN HARD RUBBER COMPANY
HARD RUBBER and PLASTICS
Since 1851
11 MERCER STREET • NEW YORK 13, N. Y.

New Materials and Equipment



The Burrell Combustron uses induction heating for the determination of carbon content by combustion.

it provides rapid analysis, instant heating, visible combustion, and a sturdy Vycor reaction tube.

It operates on 115- or 230-v. a.c. power, and is available in one- or two-tube models.

New Control System

A new control system, P.A.T. '50, recently announced by *Leeds & Northrup Co.*, 4934 Stenton Ave., Philadelphia 44, introduces rate action into an electrically actuated control. The significance of rate action is that it responds according to the speed with which the controlled variable changes—thus improving process output by reducing the length of time that an upset can force the controlled process off its set point.

Rate action is introduced into electrically-actuated control with this new Leeds & Northrup control unit.

If furnace temperature, for example, begins to fall, rate action immediately opens the fuel valve. The faster the drop in temperature, the wider the valve is opened. And, as the rate of temperature drop decreases, rate action's effect also decreases, bringing temperature smoothly back in line.

Said to offer even greater sensitivity than

BARRIER to SOUND and HEAT } "K" FELT

American Felt Company's "K" Felt is made to Army-Navy Specifications for applications where either sound absorption or thermal insulation, or both, are required. It is in wide use in airplanes, auditoriums, radio studios, and special automobile applications. Suitable for use at temperatures from below zero to 250° F. Made in rolls approximately 24 yards long and 72 inches wide, in thicknesses from ⅛ to ½ inch. Thicknesses over ½ inch are easily produced in your plant by layering. The engineering authority on the use of felt for sound and thermal insulation is American Felt Data Sheet No. 3, "K" Felt. Write for it today.

American Felt Company

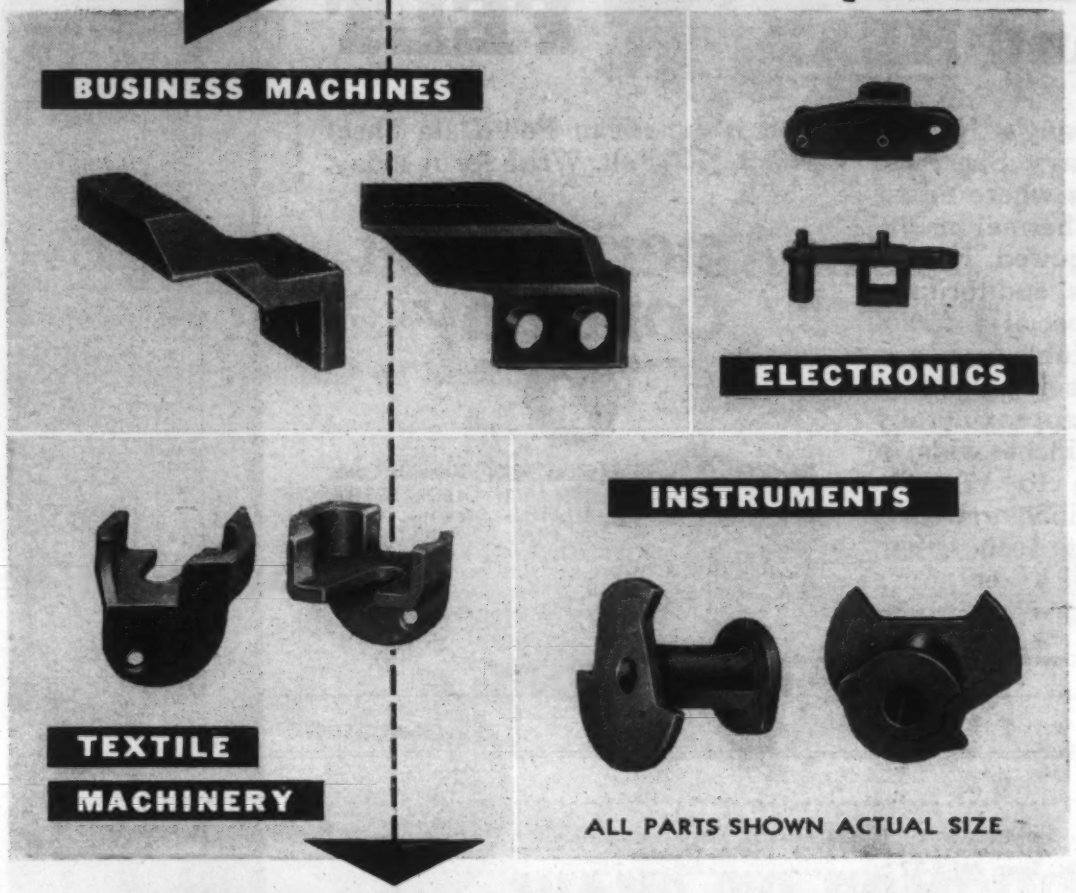
TRADE MARK

GENERAL OFFICES: 24 Glenville Rd., Glenville, Conn.
ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

PROPERTY	CHARACTERISTIC
K-Factor	0.21
Noise Reduction Coefficient, 1 in.	0.70
Flow Resistance, gm./sq. cm./sec., 1 in., Spec. AN-S-32	330
$\sqrt{RT}/S$, Spec. AN-S-32	50
Surface Density, lb./sq. yd./in.	3.24
Tensile Strength, lb./sq. in.	12
Compressive Stress, lb./sq. in. at 50% Deflection	3
Compression Set, 24 hr. loading at 50% Deflection	8%
Temperature Effect, −65° to 250° F.	None
Vibration Disintegration, Weight loss in 12 hrs. at 2000 c.p.m.	0.2%
Physical Stability in Handling or Flexing	Complete
Collapse When Wet	None
Shrinkage-Swell, A.S.T.M., D461	3%
pH Control	6.8-7.2
Corrosive Action, Aluminum, Magnesium and Alloys	None
Chemical Stability	Complete
Moisture Absorption, 24 hr. test at 125° F. and 96% R.H.	28%
Moisture Content, A.S.T.M., D461 Standard Condition, 65% R.H. at 70° F.	16%
Flame Resistance	
Propagation	None
Surface Flash	None
Afterglow, max.	30 sec.
Bacterial, Fungi and Vermin Resistance	Excellent

THICKNESS[1] Inches	SURFACE DENSITY		FREQUENCY Cycles per Second						NOISE REDUCTION COEFFICIENT[2]	CONDUCTANCE C BTU/Hr./Sq. Ft./°F.	RESISTANCE 1/C
	Lb./Sq. Ft.	Lb./Sq. Yd.	128	256	512	1024	2048	4096			
⅛	0.05	0.41	.02	.04	.06	.12	.28	.44	.10	0.85	1.17
¼	0.09	0.81	.03	.04	.11	.29	.56	.68	.25	0.68	1.47
½	0.18	1.62	.05	.07	.29	.63	.83	.87	.45	0.41	2.44
¾	0.27	2.43	.04	.17	.62	.82	.86	.83	.60	0.28	3.57
1	0.36	3.24	.06	.31	.80	.88	.87	.87	.70	0.21	4.76
										K-Factor	Resistivity
1½	0.54	4.86								0.14	7.15
2	0.72	6.48								0.13	7.69
2½	0.90	8.10								0.11	9.09

There is one RIGHT WAY to form these parts...



PRECISION INVESTMENT CASTINGS

by HITCHINER

Business Machines: An intricate part of alloy steel used on a computing machine.

Electronics: A brush holder of brass for a motor with rivets cast as an integral part of the holder.

Textile Machinery: A sewing machine part of 1020 steel cast by the Hitchiner method.

Instruments: Double cam of phosphor bronze for use on a telephone switchboard.

Illustrated are a few of the parts now used in regular production by prominent industries. Hitchiner customers include many of the leading names in practically every field of American industry where small metal parts are used.

The satisfaction of these customers is demonstrated by orders for more and more parts which are being designed or redesigned to utilize the advantages of the Hitchiner method of precision investment casting.

Hitchiner metallurgical and engineering departments have an industry-wide experience in selecting the correct materials to provide the best results, and in working closely with customers to design parts for the greatest savings obtainable. This is particularly true in the redesign of an assembly made up of several pieces into a single casting.

Send us your blueprints for competent advice on your small metal parts problems.

HITCHINER MANUFACTURING CO., INC.

Manchester, N. H.

Sales Office: 967 Farmington Ave., West Hartford 7, Conn.

AGENTS IN ALL PRINCIPAL CITIES

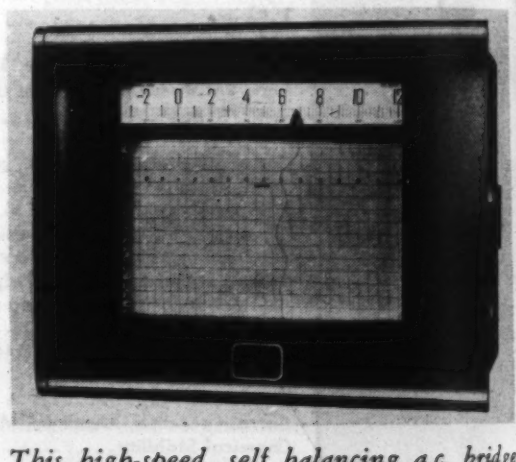
New Materials and Equipment

previous Leeds & Northrup models, the P.A.T. '50 control unit has no moving parts, control action being accomplished by electronic circuits. Valve position can be measured remotely at the control panel without interfering with control action. Major electronic components are plug-in types, easily replaced, and the entire control chassis comes out as a unit for inspection.

Electronic Measuring Instrument

Development of a new line of strip-chart electronic instruments has been announced by *The Bristol Co.*, 117 Bristol Rd., Waterbury, Conn.

The Series 500 Strip-Chart Dynamaster is a high-speed, self balancing a.c. bridge



This high-speed, self balancing a.c. bridge is used for measuring such quantities as temperature, resistance, inductance and pressure.

said to be designed for measurement of temperature, resistance, conductivity, strain, position, or any other variable that can be measured in terms of impedance. In addition, the instrument can be used to measure electric power.

Any of the measured variables is recorded on a chart 11¼ in. wide and indicated on a large scale which is legible at a distance. In addition to the single record model, instruments are available for as many as 16 different records on the same chart. Models are offered for full-scale pen travel in seven records, 3 sec. and ⅔ sec., with a full range of standard chart speeds from 1 in. per hr. to 120 in. per min.

All Dynamaster strip-chart instruments are housed in a moisture-proof and dust-proof case suitable for wall, flush-panel, or front-of-panel mounting. The scale and recording mechanisms are mounted on the front of a hinged aluminum alloy panel, which is easily swung out to gain access to the electronic components or the control mechanism.

Can Your Skeleton Use Tubular Bones?

Courtesy Cliffside Body Corporation

The "bones" in this skeleton are square steel tubes, welded together to make a stiff, rigid frame. The idea, used here to form a truck body, is easily adapted — you may find it profitable.

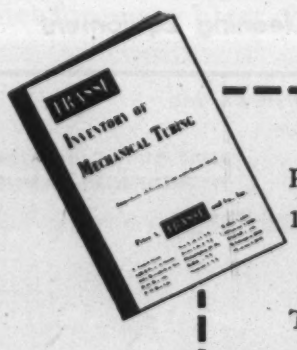
In this instance, the tubular construction, developed with the help of Frasse specialists, replaced a complicated system of bolted channels, gussets, cross fittings, angles and similar parts. Result? A stronger, more rigid, squeakless body—25% lighter, with more capacity for pay load . . . faster, neater assembly . . . greater flexibility of design . . . and 3 items to inventory instead of 60.

While mechanical tubing is widely used "to save machining the hole", it is equally handy for structural use. It pays—in product improvement, lower production cost, *often in material cost,* to think of tubing in your product.

And when you think of tubing, think of Frasse. Frasse stocks mechanical tubing, pressure, hydraulic and condenser tubing, stainless tubing—even stainless pipe and fittings. In addition, Frasse maintains a fully qualified engineering department that is always available to assist you in problems involving mechanical steels. Call us. *Peter A. Frasse and Co., Inc., 17 Grand Street, New York 13, N.Y. (Walker 5-2200) • 3911 Wissahickon Avenue, Philadelphia 29, Pa. (Baldwin 9-9900) • 50 Exchange Street, Buffalo 3, N. Y. (Washington 2000) • Jersey City • Syracuse • Hartford • Rochester • Baltimore*

Send for this FRASSE *Tubing Inventory*

This handy booklet lists each mechanical tube size immediately available from Frasse warehouse stocks — a useful reference and purchasing guide. Send the coupon for your copy today.



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Seamless and Welded Mechanical Tubing

Condenser and Pressure Tubing • Aircraft Tubing

Stainless Seamless and Welded Tubing • Stainless Pipe and Fittings

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17 Grand Street, New York 13, N.Y.

Please send me a copy of your latest Steel Tubing Inventory.

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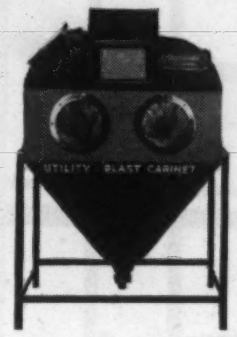
CUT PRODUCTION and MAINTENANCE COSTS

with FACTORY-ASSEMBLED Pangborn UNITS!

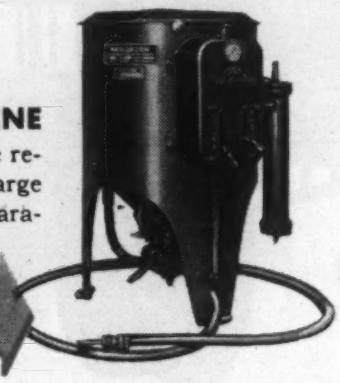
These inexpensive, ready-to-use Blast Cleaning and Dust Collecting units earn you extra profits where custom-built equipment is not practical.



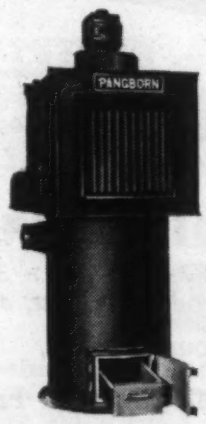
BLAST CLEANING CABINET
cleans metal parts, removes rust, scale, grime, dirt, paint, etc., in a few seconds. Ideal unit for producing clean, smooth surface on pieces up to 60″ x 36″.

BLAST CLEANING CABINETS **$315.00** and UP

BLAST CLEANING MACHINE
for maintenance and many other uses including the removal of rust, dirt, scale, etc. Economically cleans large objects such as tanks, bridges, structural work preparatory to painting. Six sizes, stationary or portable.

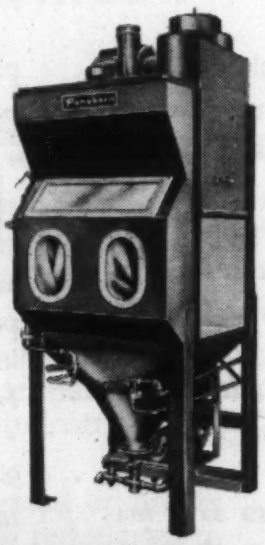


BLAST CLEANING MACHINES **$170.00** and UP



UNIT DUST COLLECTOR
traps dust at its source, minimizes machine breakdowns, reduces housekeeping and maintenance costs. Solves many grinding and polishing nuisances and material losses.

UNIT DUST COLLECTORS **$286.00** and UP



HYDRO-FINISH CABINET
uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001″.

HYDRO-FINISH CABINETS **$1295.00** and UP

MAIL COUPON TODAY!

Look to Pangborn for the Latest Developments in Dust Control and Blast Cleaning Equipment

PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.
Gentlemen: Please send me further information on—
☐ BLAST CLEANING CABINETS
☐ BLAST CLEANING MACHINES
☐ UNIT DUST COLLECTORS
☐ HYDRO-FINISH CABINETS
I am interested in the possibility of using one of these machines for.....
.....
NAME.....
COMPANY.....
ADDRESS.....
CITY..... STATE.....

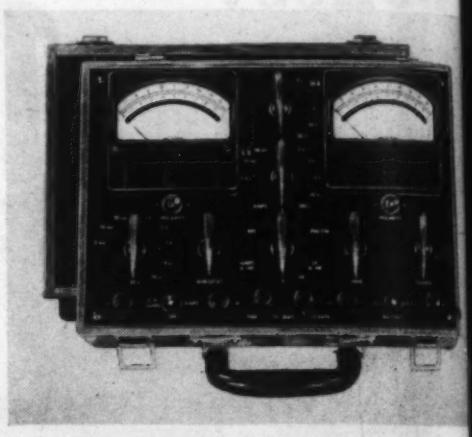
Pangborn

New Materials and Equipment

Multi-Combination Meter

A new model Multi-Combination Mete for electrolysis, corrosion and cathode-pro tection testing has been developed by M. *Miller,* 1142 Emerson Ave., West Engl wood, N. J.

With this meter, practically all measure ments encountered in electrolysis and co rosion investigations and cathodic-protectio



This new model Multi-Combination Mete is useful for electrolysis and corrosion in vestigations.

testing in field and laboratory can be made according to the manufacturer. By use of circuit selector switch, the two high-sensi tivity d.c. instruments can be connected into a variety of measuring circuits for measure ments of potential, current, resistance, and soil resistivity.

Internal batteries with switch, coarse and fine controls can be used to supply and con trol current for test purposes. Voltmeters or voltmeter and ammeter, can be used separately or simultaneously. Polarity reversing switches are provided for both current and potential measurements.

The meter is said to have been designed by corrosion engineers who incorporated improvements based on wide field experience.

●

Heating, Heat Treatment

Laboratory Furnace

A new laboratory furnace has been de veloped by the *Despatch Oven Co.,* 611 S. E. 8th St., Minneapolis, Minn., to fit the expanded needs of testing laboratories in industry. Application of cross flow convection heat with extra air volume in the

Reports from all types of foundries ow ROTOBLAST saves p to $10,000 a year and MORE!

OBLAST saves labor—industry's biggest e cost item. In each of the three typical OBLAST cases tabulated below, *savings on* r averaged well over a $100 a week. In tion, cleaning took less time and power decreased.

Save with ROTOBLAST

OBLAST NIT	CASH SAVED	NAME OF USER
-Room	**$11,102** on labor alone	Lewistown Foundry, Lewistown, Pa.
om	**$10,160** on labor alone	Harris-Seybold, Cleveland, Ohio
rrel	**$5,080** on labor alone	Yates-American Machine Co., Beloit, Wisconsin

u want savings like this, specify Pangborn OBLAST. Whether you clean castings or ngs, grey iron, brass or steel, you'll find OBLAST saves money and speeds up clean- with no sacrifice in quality!

ROTOBLAST

SAVES LABOR: *One ROTOBLAST machine and operator can do as much as a two-man crew and old-fashioned equipment.*

SAVES SPACE: *In many cases, one ROTOBLAST machine replaces five or more old-fashioned machines, requires less space.*

SAVES TIME: *Cases on record prove ROTOBLAST can cut cleaning time up to 95.8% compared with old-style methods.*

SAVES POWER: *Modern ROTOBLAST uses but 15-20 h.p. compared to old-fashioned equipment requiring 120 h.p. for same job.*

SAVES TOOLS: *On work cleaned with ROTOBLAST, cutting tools last up to 2/3 longer because no scale is left to dull edges.*

. . . and these savings mean INCREASED PROFITS for you!

ROTOBLAST* ... Cleans These Intricate Castings for 2¢ EACH!

An actual case report from Garden City Foundry, Stoughton, Wisconsin

"Reduced our cleaning costs!" says superintendent John Selgrath about Garden City's ROTOBLAST team of Table and Barrel. Costs on two intricate flywheel castings back up his statement. The smaller 31 lb. piece is cleaned by the ROTOBLAST Table shown above for only *2c each!* Larger 49 lb. flywheels are cleaned in the Barrel for just 5.3c each—and both figures include *all labor, power and operating costs!*

But that's not all. Breakage used to seriously hamper production, but no more. Cleaning is faster too, and now Garden City states it can give its customers *any finish they want!*

IF YOU WANT TO CUT COSTS TOO, find out about Pangborn ROTOBLAST. There's a ROTOBLAST Table, Barrel, Table-Room and Monorail Cabinet for every blast cleaning job. To find out how modern Pangborn ROTOBLAST equipment can save you money, send for Bulletin 214. It contains valuable specifications, performance data and photographs. For your copy, write today to: PANGBORN CORPORATION, 1700 Pangborn Blvd., Hagerstown, Maryland.

Look to Pangborn for the Latest Developments In Blast Cleaning and Dust Control Equipment

MORE THAN 25,000 PANGBORN MACHINES SERVING INDUSTRY

Pangborn

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION INC. MEMBER FEMA

*Trademark of Pangborn Corporation

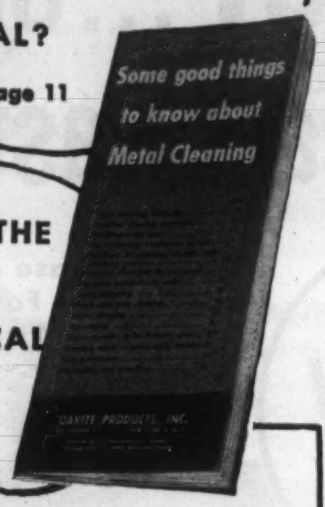
BLAST CLEANS CHEAPER with the right equipment for every job

WHAT'S THE FASTEST WAY TO CLEAN METAL?

See page 11

WHAT'S THE MOST ECONOMICAL WAY?

See page 9



Oakite's New FREE Booklet

"Some good things to know about Metal Cleaning"

answers many questions that mean better production for you, more money in your pocket. You'll want to read more about:

¶ What kind of cleaner attracts both oil and water? How does this help remove buffing compound residues and pigmented drawing compounds? See Page 8.

¶ What are the advantages of reverse current for electrocleaning steel? See page 15.

¶ Can you electroclean brass without tarnishing? See page 18.

¶ Can you clean steel and condition it for painting for less than 20 cents per 1,000 square feet? See page 26.

¶ Would you like a cleaner that removes rust and oil in one operation, often eliminating all need for pickling? See page 28.

FREE For a copy of this 44-page illustrated booklet, write Oakite Products, Inc., 32H Thames St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

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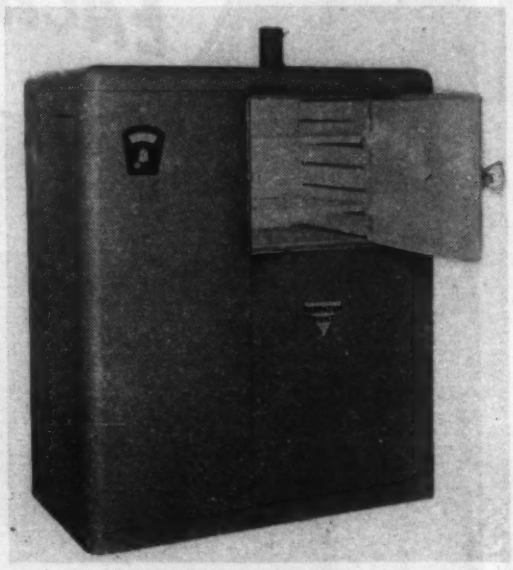
MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

New Materials and Equipment

Despatch CF line is said to speed up preheat time, provide for better penetration of products in the work chamber, and reduce time for heat recovery after new loadings.

Providing heat control accuracy and work chamber uniformity, the furnace has a temperature range up to 850 F. Swinging doors permit location of the CF furnace where less



Swinging doors permit location of new Despatch CF furnaces where little head room is available.

head room is available, allowing it to fit better into the space facilities of the average laboratory.

Despatch CF furnaces are available in either gas-fired or electric models.

Core Baking Unit

What is called the first electronic core baking turntable has been introduced by *Induction Heating Corp.*, 181 Wythe Ave., Brooklyn 11.

Ther-Monic Model 300-T is a single unit with all components in one housing. Vacuum tubes are water-cooled, allowing trouble-free operation under adverse foundry conditions, according to the manufacturer, and the manually operated electrode adjustment is rapid and accurate. Once set, the adjustment need not be changed for the entire production run.

When core production requires a change, however, it can be made in less than a minute by the coremaker himself, eliminating the need for an oven tender. Model 300-T has a capacity of 350 lb. of sand cores per hr., and is capable of baking cores up to 15 in. wide, 28 in. long and a maximum combined height of core and core plate of 8 in. The 72-in. dia. turntable has adjustable speeds of from 0 to 6 ft. per min.

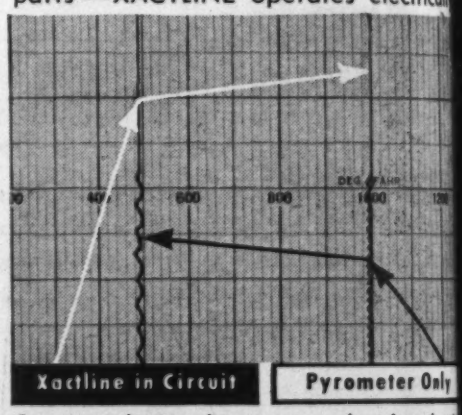
With the Ther-Monic method of core

Automatic "STRAIGHT-LINE" TEMPERATURE CONTROL with XACTLINE

ELIMINATE Overshooting Undershooting

Are you going to continue to put up with that troublesome overshooting and undershooting inherent in your conventional pyrometer control — especially when it is so easy to eliminate that saw-tooth effect?

Put XACTLINE in the control circuit. XACTLINE anticipates the temperature changes — before they occur. And too it nullifies the varying amounts of thermal lag, residual heat, and mechanical lag — producing a short on-off cycle resulting in "Straight-Line" temperature control. This performance is possible because there is no dependence upon mechanical parts — XACTLINE operates electrically.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

XACTLINE is applicable to any indicating or recording pyrometer control of the millivoltmeter or potentiometer type. It should be used wherever close temperature control is required — any type of electrically heated oven, furnace, kiln, injection molding machine, and fuel-fired furnaces equipped with motor-operated or solenoid valves.

XACTLINE is a complete unit. No adjustment or coordination with the control instrument is required regardless of the size of the furnace, length of the heating cycle, or size of the load. Installation is very simple — can be either flush or surface mounted.

PRICE **$89.50** F.O.B. CHICAGO

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Specialists for 36 Years in the Heat Treating and Temperature Control Field

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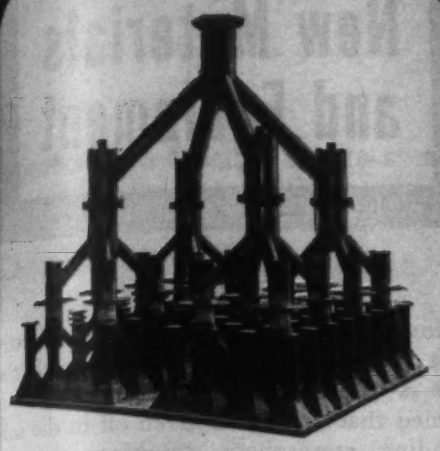
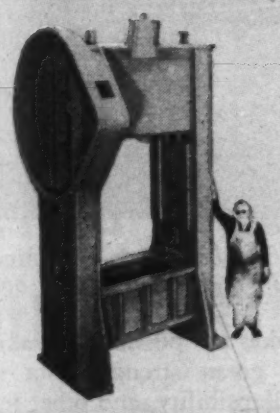
Steel-Weld FABRICATION

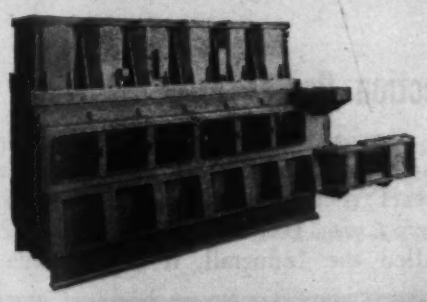


One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

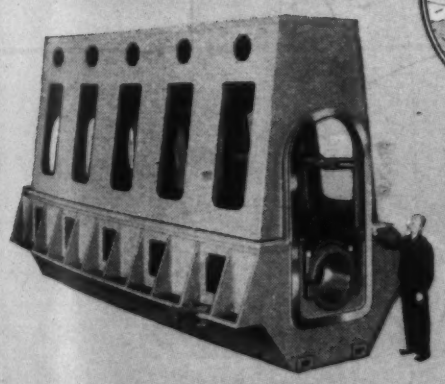
Pressure Vessels for the Chemical and Allied Industries.



Heavy Press and Machine Frames and Bases for the Machine Tool Industry.

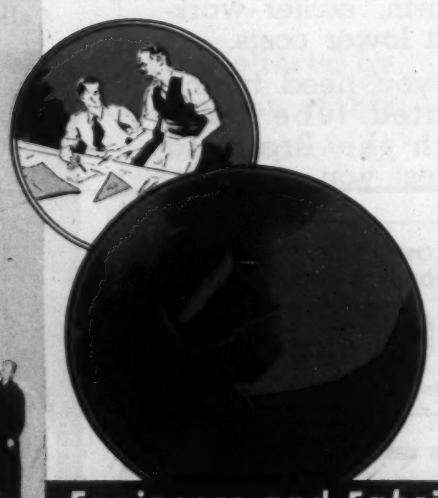


Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.



Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type.

This massive Marine Engine Frame was Steel-Weld Fabricated and completely machined ready for assembly by the Steel-Weld Division of The R. C. Mahon Company.



Today, many parts and major assemblies of heavy machinery and equipment are economically produced in welded steel . . . units illustrated on this page are typical of thousands of Steel-Weld Fabricated parts produced by Mahon for manufacturers throughout the country. If your product—or parts of it—lends itself to this production technique, you will find savings in time and cost through Steel-Weld Fabrication. If you investigate, you will also find in the Mahon Company an unusual source for welded steel in any form for any purpose . . . a source with complete, modern fabricating and machining facilities, backed by a staff of competent design engineers and craftsmen from whom you may expect a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

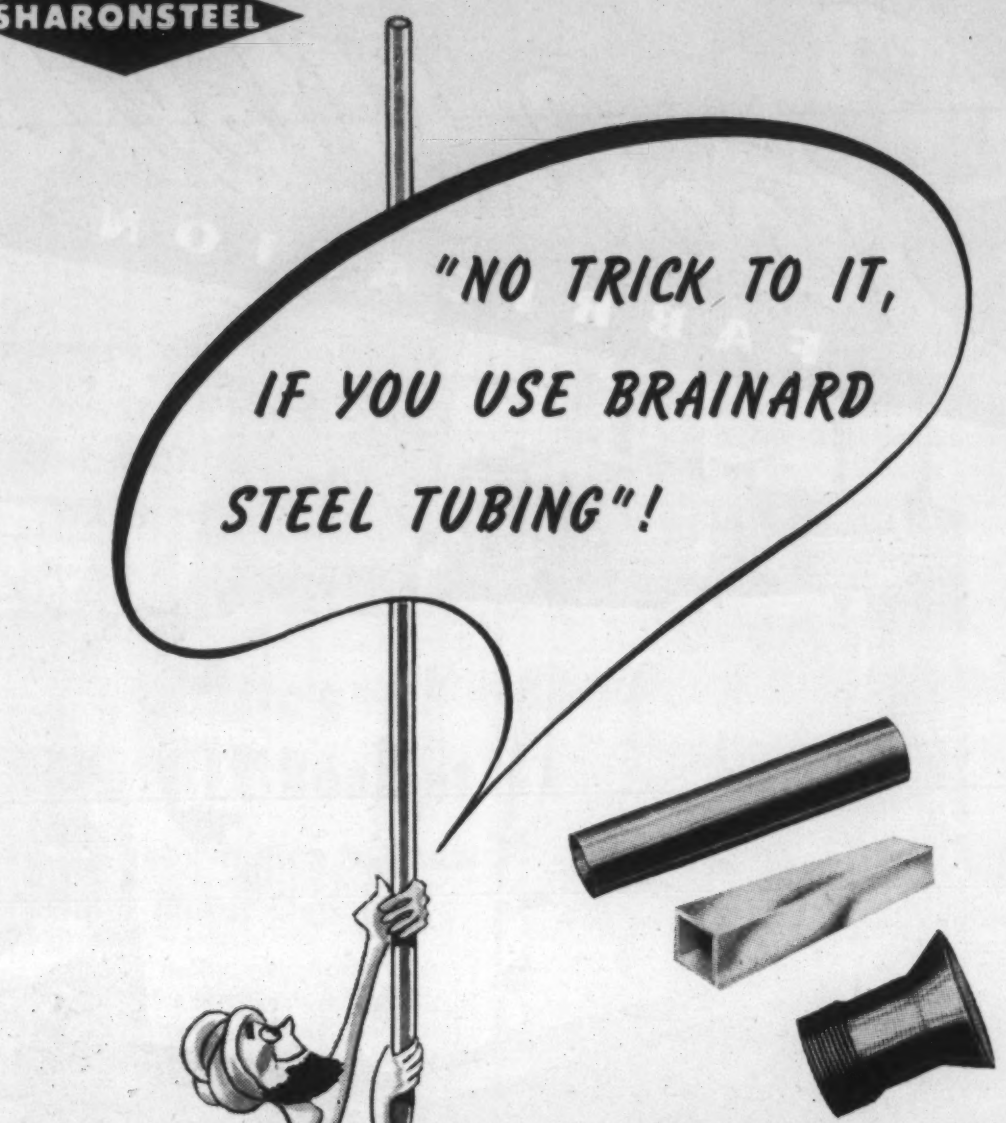
THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

SHARONSTEEL

"NO TRICK TO IT, IF YOU USE BRAINARD STEEL TUBING"!



These India lads would probably never use steel tubing to perform their famous trick, but if they did they wouldn't be able to find a better tubing than Brainard high quality welded mechanical steel tubing.

As manufacturers who now use Brainard tubing know, they need no tricks to bend, form, swage or otherwise fabricate—for Brainard tubing is quality controlled from ore to product to assure a more uniform, easier-working tube at lower costs.

Next time you need tubing or fabricated tube parts check with the Brainard office nearest you.

QUALITY CONTROLLED FROM ORE TO PRODUCT BY BRAINARD

Straight or Fabricated

SIZES: 1/2" to 4" — .025 to .165

TUBING DIVISION

BRAINARD STEEL COMPANY

23311 LARCHMONT AVENUE WARREN, OHIO

There are Brainard sales offices in Atlanta, New York, Cincinnati, Pittsburgh, Buffalo, Chicago, Philadelphia, Detroit, Cleveland, Indianapolis and Nashua, N. H. Sales Representatives: Sharonsteel Products Co. in Detroit, Grand Rapids, Mich.; and Farrell, Pa. Fred J. Reynolds, Davenport, Ia; Brass & Copper Sales Co., St. Louis, Mo.

New Materials and Equipment

baking, all fumes are exhausted directly from the core room. Inasmuch as all the heat is generated within the cores, it is claimed that no heat is given off to the surrounding atmosphere, resulting in more comfortable working conditions in the core room. This equipment, together with resin

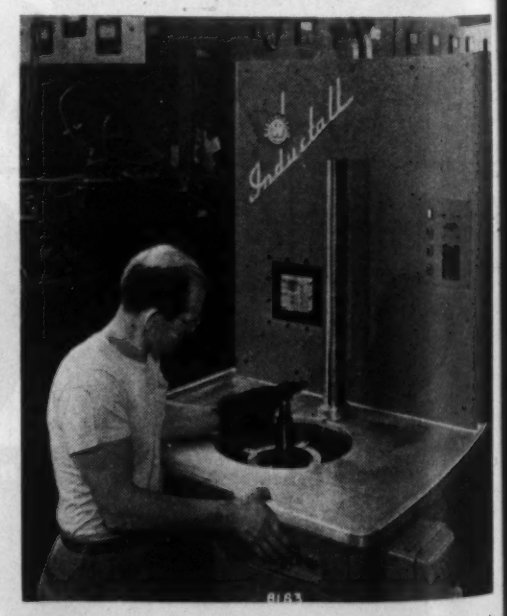
Model 300-T, the latest Ther-Monic core baking unit, requires only one operator.

binders, makes it possible to adjust and control the green strength, hot strength, hardness, collapsibility, and other important characteristics of the core.

Induction Heater for Gears

A new radio-frequency gear hardening machine for high-production heat treating of gears is available from *Westinghouse Electric Corp.*, Box 2099, Pittsburgh 30, Pa.

Called the Inductall, it is used with a



High-production heat treating of gears is made possible by this radio-frequency gear hardening machine.

7,000 POUND CASTING OF "18-8" STAINLESS STEEL. Produced by The Ohio Steel Foundry Company at its Lima, Ohio plant, this turbine runner meets A.S.T.M. A-198 Grade A Specification.

Performance

...improved with 18-8 Stainless Steel Castings

HERE'S a turbine runner cast in 18-8 chromium-nickel stainless steel to secure the utmost in resistance to corrosion, erosion and cavitation...

The unique combination of properties offered by 18-8 stainless steel merits your consideration of this material when designing new products or improving old ones.

In many instances stainless helps you trim bulk and deadweight. Moreover, it can assure longer service life because these chromium-nickel alloy steels resist attacks from many corrosive media, particularly oxidizing acids.

At elevated temperatures austenitic stainless steels resist creep, scaling or oxidation. At low temperatures they remain tough and offer exceptional resistance to impact.

We invite your inquiries on the use of cast or wrought stainless alloy steels containing nickel. Send us details of your problems for our suggestions.

EMBLEM OF INCO SERVICE TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Alnor

Velometer

gives instant, direct reading of Air Velocity . . . Anywhere!

Here is a precision-built, self-contained, portable instrument that gives instant, accurate reading of air velocities—anywhere. Measures speed of flow through ducts, grilles, motors, furnaces, etc., or in the open. Needs no calculations or reference charts. Anyone can use it and get accurate measurements. Available in a wide range of scales, and with a wide assortment of jets and fittings if needed. You'll want full details and prices, so write for Bulletin No. 2448-G. Illinois Testing Laboratories, Inc., Room 522, 420 N. La Salle Street, Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

New Materials and Equipment

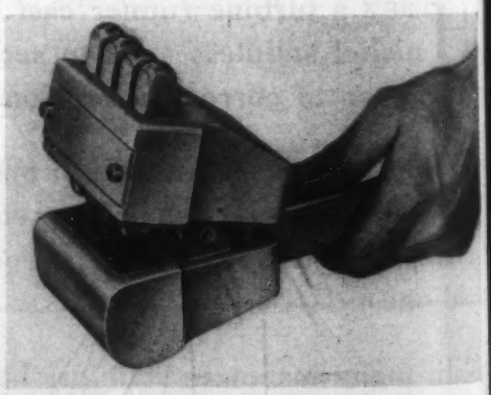
vacuum tube radio-frequency generator, a 10,000 cyclemotor-generator set, and other associated equipment to harden spur gears, cluster gears, integral spindle gears, and shafts. Each gear processed undergoes an automatic cycle for either through- or contour hardening. Uniformity of hardening is said to result from the mechanical gear handling system and precise electrical timing of the pre-heat, heat treat and quench operations.

The Inductall system is flexible, lending itself readily to expansion to meet increased production requirements. It is simple to operate and maintain, and does not require skilled labor for operation. Designed for in-line production methods, it can help reduce handling costs, work-in-process inventories, and associated storage problems.

General

Marking Device

A new marking device for stamping steel sheet, strip, and other flat metals has been developed by *M. E. Cunningham Co.*, 155 E. Carson St., Pittsburgh 19, Pa. Made from aluminum, the Model JG-1 stamping tool is said to be light, easy to handle, and can



Steel sheet, strip and other flat metals can be conveniently marked with this light weight, aluminum stamping tool.

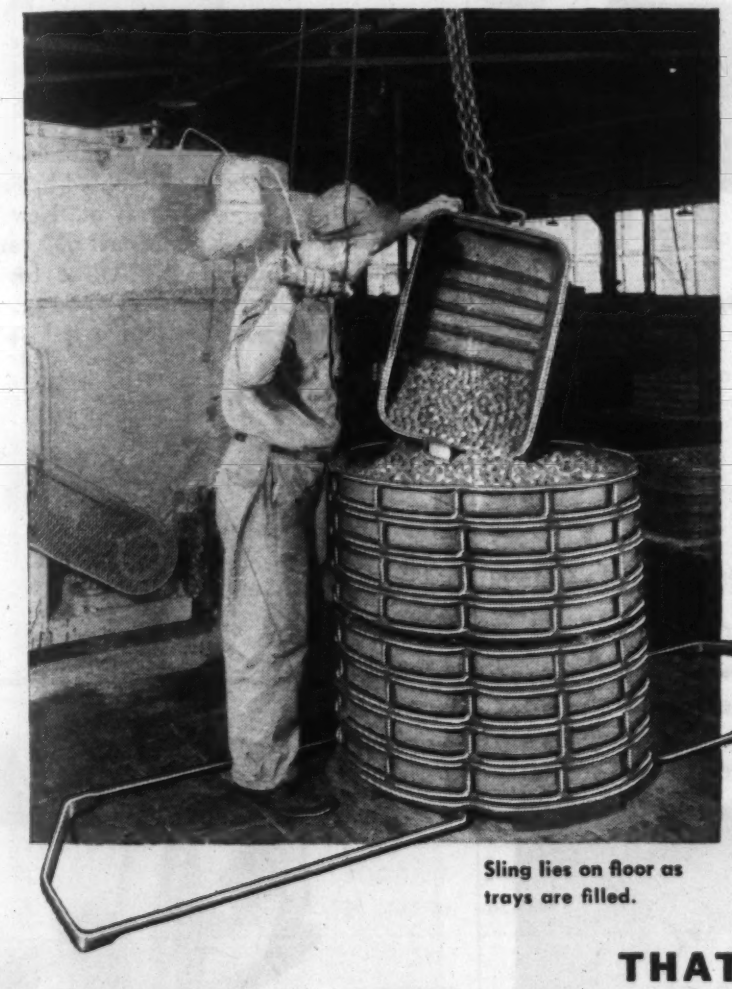
be manufactured with a holder section for accommodating almost any size or number of characters.

Only finger pressure is required to swivel the top upward so the holder can be slipped over the pieces to be marked. When pressure is released, springs drop the top into position for marking. To complete the marking operation, each stamp is struck individually with a lightweight hammer.

Specially designed springs retain the

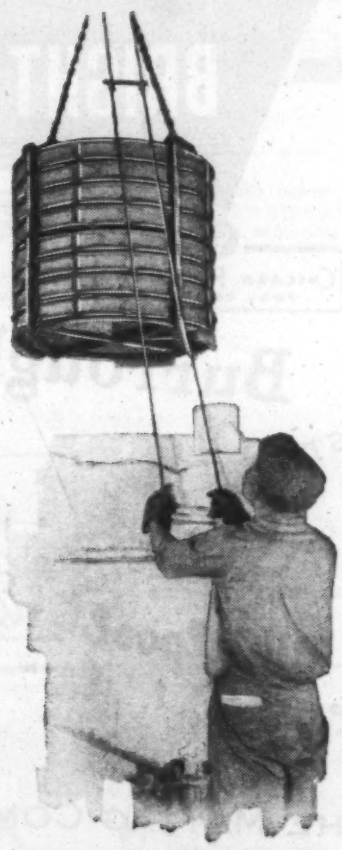
ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS



Sling lies on floor as trays are filled.

Sling is raised to fit into indentations.



Sling safely holds assembly as it is hoisted to furnace.

3 SLING SHOTS

THAT SCORE FOR *CRUCIBLE STEEL*

The three camera shots above clearly picture the three principal advantages of this fabricated-welded stainless steel tempering assembly. Both Rolock and Crucible Steel engineers contributed to the design which features: (1) a rugged carrier sling, (2) indented trays for close, safe fit of sling, (3) maximum furnace capacity.

The shallow, easy stacking trays separate varied sizes of Alnico permanent magnets and a thermocouple is used between the fourth and fifth trays ...with another one on the top. The assembly weighs 665 lbs., maximum load 3200 lbs., a ratio of 4.8 to 1.

Rolock job-engineered heat treating equipment will speed handling, give you more uniform quality, lengthen service life and reduce work-hour costs. If you have such problems, call our Rolock engineers for practical recommendations.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • INDIANAPOLIS • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS

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JOB-ENGINEERED for better work
Easier Operation, Lower Cost

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USING Ipsen
AUTOMATIC 'T' UNITS FOR

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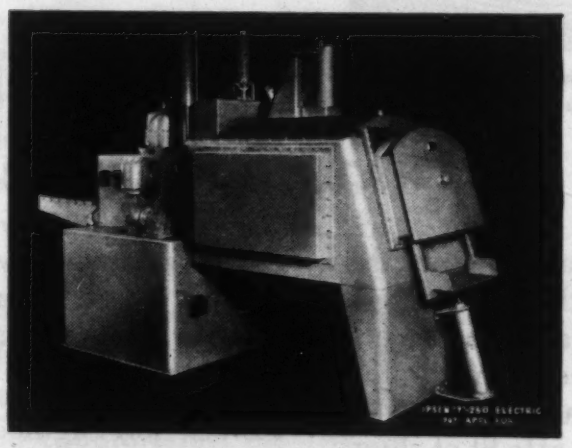

THE AUTOMATIC Ipsen HEAT TREATING UNIT

MAIL THIS COUPON TODAY!
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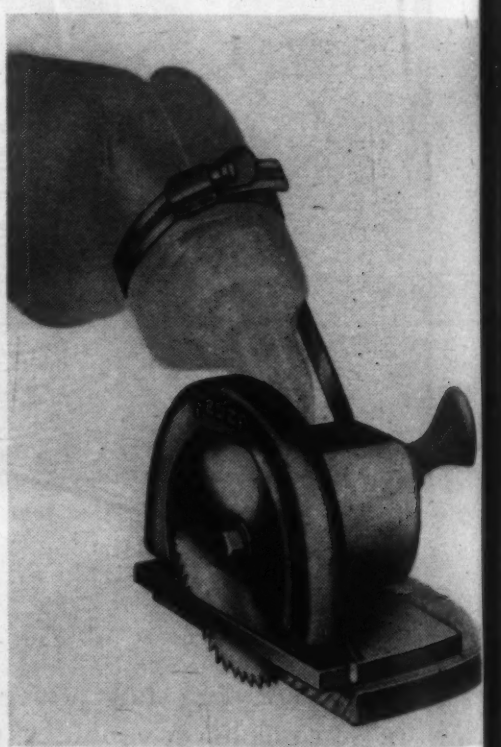
IPSEN INDUSTRIES, INC.
300 N. MADISON STREET • ROCKFORD, ILLINOIS

New Materials and Equipment

stamps in the holder and permit rapid changing. A steel piece on the bottom of the holder, around which the aluminum is cast, serves as an anvil—holding distortion of the stamped metal to a minimum.

Saw Attachment

A new, gear-driven saw attachment for ¼-in. drills has been announced by *Federal Engineering Co.*, 37 Murray St., New York 7. The Fedco Saw-Rite, Model 600, features adjustable depth of cut, Oilite bearings, precision-cut hardened steel drive gears, an all-aluminum housing, and a quick-acting



This Fedco Saw-Rite saw attachment will cut hardwoods, wallboard, plywood or plastics.

worm-driven clamp for holding the attachment in correct alignment with the drill.

Designed for one-hand use, the attachment has a knob for convenience when two-hand operation is desirable. With depth of cut adjustable from ⅛ to 1⅛ in., the saw can be used for cutting grooves, dadoes, rabbits and ploughing. The combination blade is usable for either rip or crosscut, and the saw is said to cut any material—hardwoods, wallboard, plywood or plastics.

Hand-fitted and balanced, the 4-in. dia. blade is of chromium-nickel alloy steel and will cut thousands of feet before resharpening is required. Material up to 2 in. thick can be sawed in two cuts, one from each side.

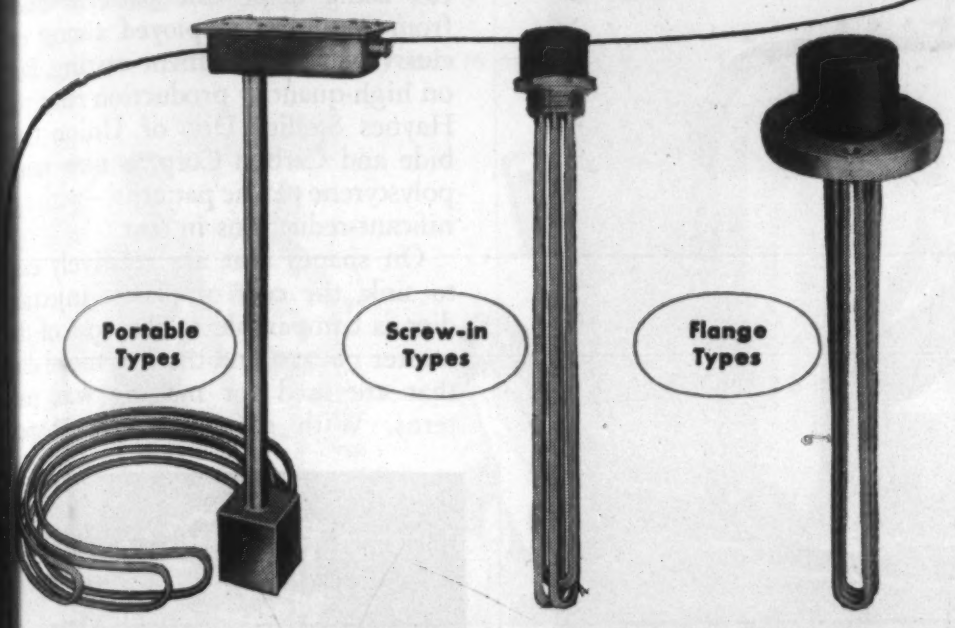
CHROMALOX

Electric Immersion Heaters

for Heating Water, Oils

Waxes, Heat-Transfer Mediums

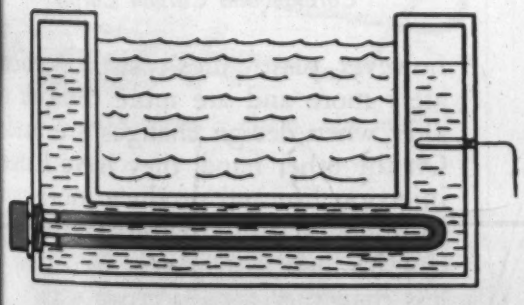
and other Liquids



Look to CHROMALOX for Dependable Electric Heat

CHROMALOX Electric Immersion Heaters come in a full range of types for permanent or portable use. They are quickly and easily installed with minimum labor and material costs . . . and they may be manually or thermostatically controlled for accurate, care-free, dependable operation. Available in types and sizes to fit your needs in iron, steel or alloy sheaths to resist corrosion.

If you are interested in heating liquids efficiently, or if you have any other heating problem—you are invited to consult CHROMALOX.



A Typical application

Indirect immersion heating with Chromalox Electric Tubular Heaters.

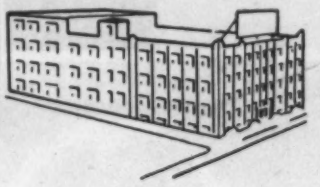
OTHER UNITS AVAILABLE FOR HEATING:

Water, asphalt, greases, molten salts, pickling baths, Dowtherm, Aroclor, Prestone—for superheating steam and compressed air—for melting lead, solder, babbit and stereotype metal.

CHROMALOX

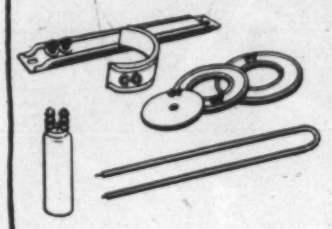
offers you the most in Electric Heat

Experience



33 years experience in electric heating, covering almost every industrial process employing heat up to 1000F°

Selection

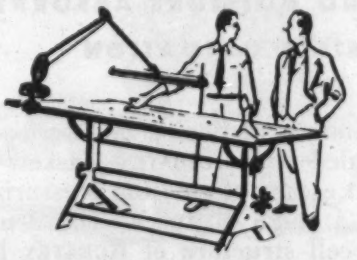


Over 15,000 types, sizes and ratings to fit most every application requiring heat.

Service

135 field engineers in 37 cities throughout the country, to give you on-the-job counsel and assistance.

Engineering



Application engineers working with research, development and manufacturing personnel provide technical know-how for solving industrial heating problems.

FOR COMPLETE INFORMATION Write for Catalog 50 which describes the complete Chromalox facilities and products designed to meet your heating requirements.

EDWIN L. WIEGAND COMPANY IC-49
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Please send me a copy of the new 48 page Chromalox Catalog.

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CHROMALOX

Electric Heat for Modern Industry

RUBATEX

seals the windows of the Stratocruiser

◀ **AIRTIGHT UNDER PRESSURE DIFFERENTIAL**
◀ **DOESN'T SCORE OR CRAZE PLASTICS**
◀ **UNAFFECTED BY TEMPERATURE CHANGE**
◀ **ZERO MOISTURE ABSORPTION—WEATHERPROOF**
◀ **RESISTS OXIDATION**

The windows of Boeing Stratocruisers are sealed with RUBATEX Gaskets to prevent escape of air from pressurized cabins at high altitudes. The dense, sealed cell structure of RUBATEX has excellent compressive strength, high resiliency and forms a leakproof joint without crazing or scoring the plastic windows. It compensates for irregularities in adjoining surfaces and has high insulating properties.

RUBATEX Closed-Cell Rubber cannot absorb moisture even at cut edges. It is rot and vermin proof. Most gasket requirements can be cut from sheet stock, thus avoiding the expense of a molded skin.

Consider RUBATEX for your gasketing, cushioning, shock-absorbing or vibration damping applications. It is available in natural and synthetic stocks in soft, medium and firm forms. Our engineers can give you valuable assistance from their experiences with countless other uses. For further information write for Catalog RBS-12-49. Great American Industries, Inc., RUBATEX DIVISION, BEDFORD, VIRGINIA.

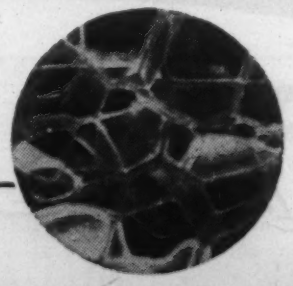


Photo-micrograph shows how each cell is completely sealed by a wall of rubber. The material cannot absorb moisture. It has high insulating values, is highly resistant to oxidation and is rot and vermin proof.

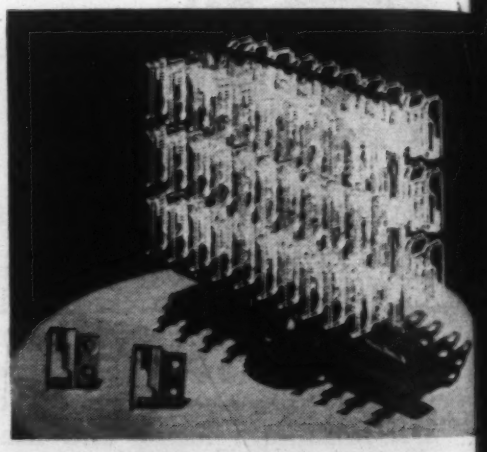
RUBATEX® *CLOSED CELL RUBBER*

Plastic Patterns Cut Investment-Casting Cost

● METAL PARTS can now be investment-cast more economically than ever before by the use of patterns made of plastic instead of wax.

Until recently, the "lost-wax" process, using disposable patterns made from wax, was employed almost exclusively for investment casting. But on high-quantity production runs, the Haynes Stellite Div. of Union Carbide and Carbon Corp. is now using polystyrene plastic patterns—with significant reductions in cost.

On shapes that are relatively easy to sink, the cost of plastic injection dies is comparable to the cost of the master pattern and the soft metal dies that are used for making wax patterns. With more intricate shapes



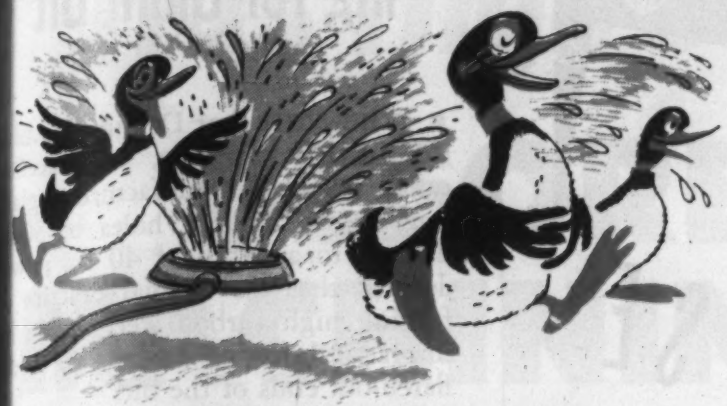
Polystyrene plastic patterns, such as the array shown here, have begun to replace wax patterns for investment casting on large-scale production runs. (Courtesy Union Carbide and Carbon Corp.)

however, plastic dies cost proportionately more and are more difficult to alter when design changes are made. On the other hand, they have longer injection life and produce more uniform and accurate patterns. Also, the cost for injecting plastic into dies is less than that for injecting wax.

Although wax patterns are more economical on small-volume runs because of the lower die cost, the higher cost of a plastic injection die is usually offset on production runs of from 5,000 to 10,000 pieces, while production beyond this quantity results in definite savings.

When either the alloy or the design is in question, castings for test purposes can be made by machining patterns directly from polystyrene plastic and mounting them individually for casting.

It's a fact that



AlSiMag is impervious to moisture

AlSiMag is as light as aluminum

AlSiMag is harder than granite

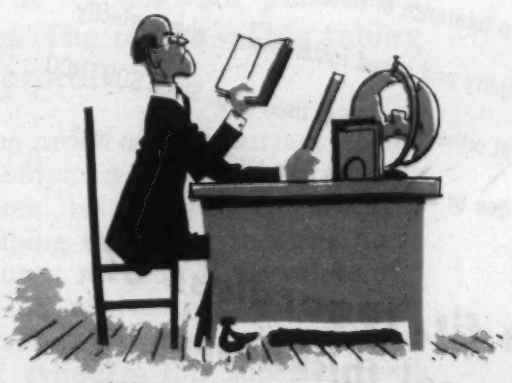
AlSiMag does not rust, oxidize or corrode

AlSiMag is non-magnetic

AlSiMag has higher insulation at high temperature than fused quartz

AlSiMag withstands higher compressive loads than steel

AlSiMag is chemically inert



AlSiMag is permanently rigid

AlSiMag has lower coefficient of expansion than any commonly used metal

AlSiMag

TRADE MARK REGISTERED U.S. PATENT OFFICE

CUSTOM MADE TECHNICAL CERAMICS

AlSiMag is the trade name of a large family of versatile ceramics. Among the many AlSiMag compositions, you may find one which has exactly the physical characteristics you need. AlSiMag makes parts to your blue prints, cooperates on design when desired. These parts come to you ready for your assembly line. They are uniform, dimensionally accurate, and are economically fabricated in quantity. The AlSiMag Property Chart is sent free on request.

AMERICAN LAVA CORPORATION

49TH YEAR OF CERAMIC LEADERSHIP

CHATTANOOGA 5, TENNESSEE

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never too TIGHT
— never too LOOSE

SOUTHCO screw type
REMOVABLE FASTENERS

Are you losing valuable production time in installing access doors and panels because the "correct length" fastener won't always fit?

If slight differences in panel thicknesses cause the grip of your fasteners to vary between too tight and too loose,

SOUTHCO can solve your problems!

Grip ranges of SOUTHCO Screw Type Fasteners will allow from 2 to 30 times the grip tolerance of conventional 90° lock and turn fasteners. They simplify and speed installations—give perfectly uniform tightness at either extreme of their grip. Stock SOUTHCO fasteners in only one or two sizes to take care of all your jobs.

A perfect fit, regardless of varying panel thicknesses

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE

SOUTH CHESTER CORPORATION
1404 Finance Building
1418 South Penn Square
Philadelphia 2, Pa.

SOUTHCO ®

Hard Surfaced Casting for Giant Bit

● WHEN THE Star Drilling Machine Co. of Akron, Ohio, was recently called upon to manufacture a giant star bit for drilling holes of 30-in. dia. up to a depth of 40 ft., it was decided that the normal practice of forging high carbon steel would be impractical for producing the wide flared-out ends of the bit.

Instead, 0.5 carbon steel was cast to produce a bit slightly smaller than the specified size. Then the gage and face points, the fastest wearing areas, were built up with several layers of hard surfacing materials. Use of the weld metal is expected to extend service life and to facilitate rebuilding the bit when it becomes worn.

After casting the bit, the points of

Layers of hard surfacing material on the face and gage of this cast steel star drilling bit extend its service life considerably. (Courtesy Lincoln Electric Co.)

the face were first built up with a single pass all the way across in each direction, using a Hardwell 100 electrode, a high carbon type manufactured by The Lincoln Electric Co. of Cleveland. This electrode was selected for the first pass because the deposit approximated the analysis of the casting.

Next, a single pass of Lincoln's Abrasoweld, a semi-austenitic, abrasion and impact resistant, self-hardening material, was placed on each side of the center point all the way across. Finally, a single pass of the same filler metal was deposited directly on the point.

A similar process was employed with the gage of the bit, which was first built up almost to size and desired contour with several passes of the high carbon electrode. Both the sides and the face were welded as needed, after which this hard deposit

(Continued on page 140)

ROCKRITE TUBING

Has High Surface Finish BEFORE MACHINING!

PROVED BY PROFILOMETER RATINGS AS LOW AS 5 MICROINCHES

You can trim machining costs of ring shaped and cylindrical parts with Rockrite Tubing because it reaches your plant with close tolerances and smooth surfaces. The reason? This tubing is sized by a distinctively different process:

• Dies compress the metal against a mandrel, tending to iron out small irregularities on both the inside and outside surfaces. The metal flows from high spots in the same manner as when it is forged.

• A certain amount of planishing action also takes place on the inside surface of the tube as it elongates under the pressure of the dies and creeps forward while in contact with the mandrel.

• In no part of this operation is there any action which can produce longitudinal scratches. The metal is not drawn through a die and over a mandrel.

The proof of high surface finish? Profilometer readings recently taken on samples of Rockrite Tubing exhibiting superior finish show a range of RMS values of 5 to 55 microinches. In the manufacture of parts such as hydraulic cylinders this superior finish means substantial cost-savings well worth investigating.

HOW DO YOU SCORE? Do you know the three requirements essential for tube accuracy and lower-cost machined parts? New bulletin tells answers . . . gives more facts and figures on close-tolerance Rockrite Tubing. Send for your copy today.

ROCKRITE saves more than any other tubing

- **Higher cutting speeds**
- **Tools last longer between grinds**
- **Work-surface finishes are better**
- **Machined parts have closer tolerances**
- **Stations on automatics are often released for additional operations**
- **Extra-long pieces available—less downtime for magazine stocking and fewer scrap ends**
- **Closer tolerances often eliminate necessity for machining on outside or inside**

TR-118

ROCKRITE TUBING

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

This is

STAINLESS PLATE

PATTERN CUT

by G. O. CARLSON, INC.

High Speed powder cutting equipment developed by G. O. Carlson, Inc., makes even odd-shaped plates like these a routine operation in our plant.

Perhaps you, like so many of our customers, would prefer to specify Carlson stainless plates delivered cut to pattern. Working from your prints, templates, or even a rough sketch we are able to lay out and produce the job with the most economical use of material. In addition, freight charges are held to a minimum and the plates are received ready for finish machining.

Send your next order to G. O. Carlson, Inc.—Stainless steels of chemical quality in all analyses are our only business . . . take advantage of our specialization . . . it pays.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

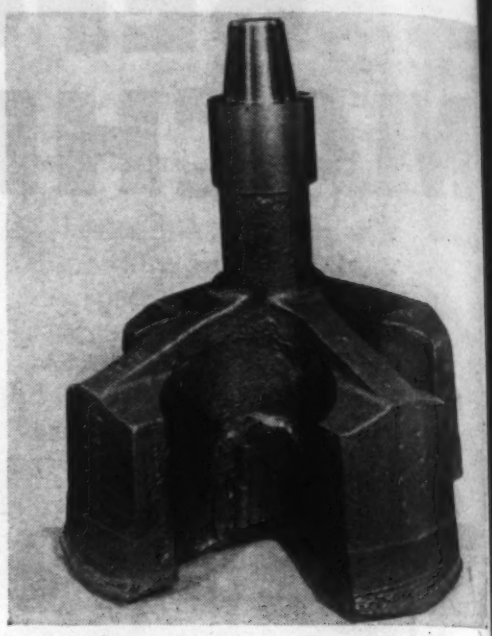
District Sales Offices and Warehouse Distributors in Principal Cities

Hard Surfaced Casting

continued from page 138

was covered with two passes of semi-austenitic material.

All welding with Hardweld 100 was done with a 3/16-in. dia. electrode at 200 amp., with the electrode



Designed for drilling holes of 30-in. dia. to a depth of 40 ft., the giant drilling bit is cast slightly smaller than specified size in 0.5 carbon steel and then built up with hard surfacing material. (Courtesy Lincoln Electric Co.)

negative for faster melt-off. Abrasoweld was deposited with a 3/16-in. electrode at 160 amp. with the electrode positive. A slight preheat of about 200 F, just warming the casting, was used before welding to eliminate the quench effect of the large mass of metal on which the welding was done.

COMING SOON!!

"Materials & Methods Manuals"

Annual Engineering Review

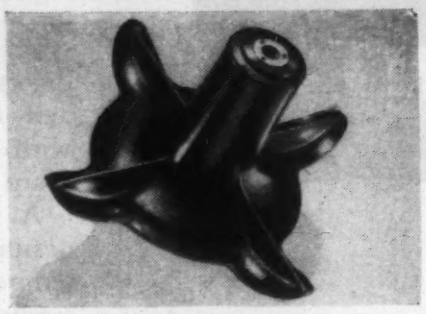
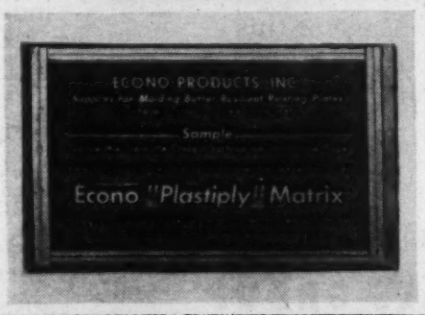
Glass as an Engineering Material

Nondestructive Testing Methods

Wrought Aluminum Alloys

Die Castings

HOW TO CHOOSE YOUR
SPECIAL PROPERTY GRADE
PHENOLIC MOLDING COMPOUND

What do you make?		Properties you need	DURITE recommends
Washing machine agitators.		Good impact strength, resistance to soap solutions and moisture.	DURITE: 745 Black or red.
Bearings, sleeves, casters, anti-friction parts.		Self-lubrication, high mechanical strength, good finish.	DURITE: 558 Black.
Electro sprayer body and handle.		Excellent resistance to mild acid and alkaline solutions.	DURITE: 745 Black.
Printing plate matrices.		Good finish and dimensional stability, non-sticking.	DURITE: S-2672-B Black.
Bushings.		Excellent dimensional stability, lowest friction.	DURITE: 550 Grey.

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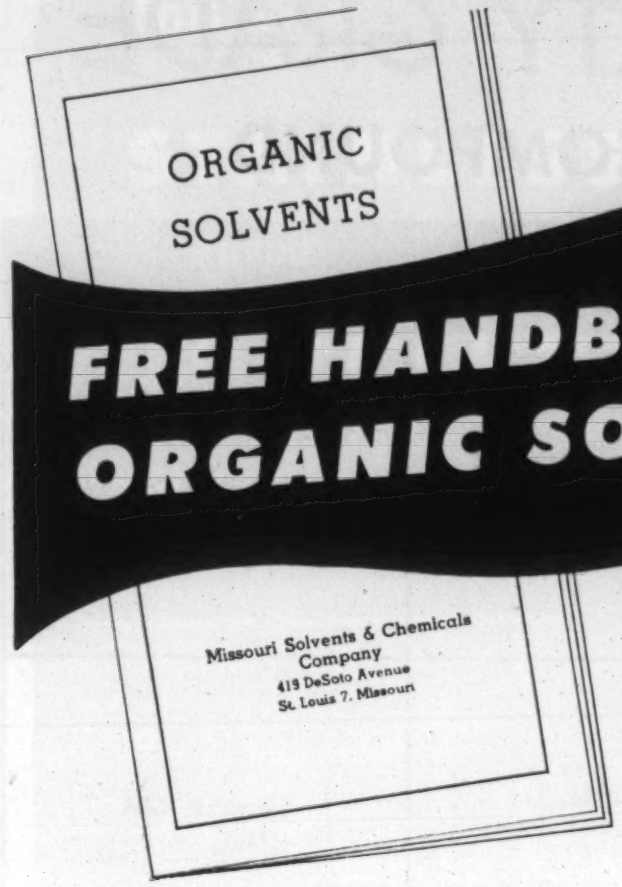

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GRAND RAPIDS—WOLVERINE SOLVENTS, 1500 Century Ave. S.W.....Gr. Rap. 5-9111
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ST. LOUIS—MISSOURI SOLVENTS, 419 DeSoto St.....GArfield 3495
TOLEDO—WESTERN SOLVENTS, Central & Reynolds Rd.....Jordon 0761

News Digest

Literature Survey . . . .

continued from page 9

mended by different authorities vary from 1/8 to 36 in. per sec. Rather deep draws can be achieved in one stroke, and there is little or no difficulty with "spring-back" or critical-strain grain growth.

A method of deep drawing magnesium alloys up to 40% at room temperature with resultant gains in strength compared to hot pressing has been developed. The process utilizes a small calcium additions to the alloy and intermittent applications of load, which increases for each cycle.

Copper

Copper is characterized by high ductility and low rate of work hardening, but its relatively low tenacity makes it harder to shape than good-quality alpha brass. There are no great difficulties in the deep drawing of copper, but if interstage annealing is necessary, it must be done in a controlled atmosphere. Best deep drawing properties are found in high-conductivity copper, with deoxidized copper second best. Deep drawing characteristics of brass are well known, and other copper alloys, including tin bronzes, aluminum bronze and beryllium copper, can also be deep drawn.

Nickel

Nickel, cupro-nickel, nickel silver, monel and Inconel all have excellent deep drawing properties. Difficulties sometimes experienced are usually caused by incorrect interstage annealing techniques and atmospheres. Special techniques recommended for nickel, monel and Inconel are: (1) special lubricants to keep friction at a minimum; (2) construction of dies to permit as free a flow of metal as possible without formation of wrinkles; (3) presses with slow, smooth action; and (4) bright annealing.

Zinc

Zinc is deep drawn at elevated temperatures with 75 to 120 F giving the most useful combination of ductility and tenacity. Sheet must be of high purity, with average grain size not more than 0.05 mm. Because of the low tenacity of zinc, care is necessary to avoid breakage in the press.

Common-Sense Equipment Protection during STEEL SHORTAGES

WITH SHORTAGES again threatening, Stoody Hard-Facing returns to war-time importance . . . the job of keeping equipment on the go, of combating all replacement scarcities by making the old parts do.

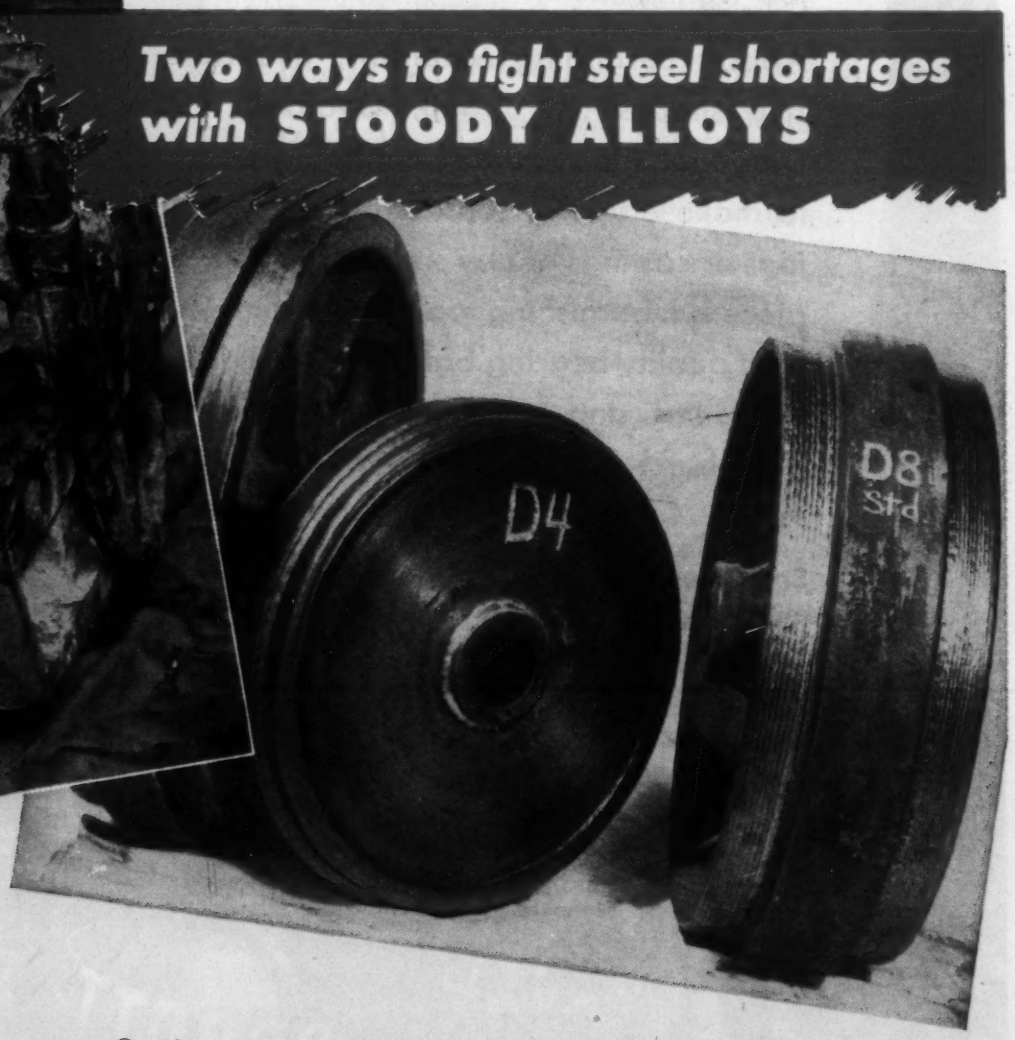
Surprisingly, Stoody Hard-Facing not only reclaims worn equipment, *but actually restores it to better-than-new condition* at less than new-part cost. Since only the areas of concentrated wear need protection, the job is simple and economical.

A part whose life is doubled—or tripled—not only conserves dollars but protects your precious inventory of spare parts when replacements become difficult or impossible to obtain.

Start making your steel go farther now with this common-sense protection . . . Hard-face all wearing parts with STOODY ALLOYS, touch up as required for ultimate life. It's your best insurance against wear at *all* times.

● *This illustration shows a worn RD-8 Tractor Idler wheel manually hard-faced with Stoody Self-Hardening. It outwore two new wheels. Application cost was only a fraction of replacement cost.*

Two ways to fight steel shortages with STOODY ALLOYS



● *Above are typical idlers automatically hard-faced with Stoody 105. Automatic welding insures greater smoothness and uniformity of deposit besides lowering cost.*

STOODY COMPANY 11959 EAST SLAUSON AVENUE, WHITTIER, CALIFORNIA

in BURNISHING MATERIALS

it's the SHAPE that counts!

Smooth burnishing of rounded corners, undulating curves, deep depressions and rounded projections is the special job of Abbott Ovalballs. They're shaped to do the job right!

Abbott Burnishing Materials, available in five shapes . . . Ball, Ovalball, Cone, Diagonal, Pin . . . are scientifically designed to make effective contact on metal stampings or castings of any size and shape. Each piece is a burnishing tool made from Abbott high quality bearing ball steel. Each is deep hardened and polished to a mirrorlike, glass-hard finish. For the *best* burnishing results . . . use Abbott!

Some parts require a special mixture of Abbott Burnishing Shapes. Send for catalog . . . No obligation.

THE ABBOTT BALL COMPANY

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ABBOTT

the all round ball

News Digest

No annealing is necessary, as recrystallization takes place at the temperature attained in press operations. For this reason, one of the main difficulties is prevention of excessive grain growth.

News of Engineers

Laurence H. Carr, chief metallurgist, has been named director of engineering and research for Edward Valves, Inc. Another appointment in the company was that of *Carl W. Nedderman* as assistant vice president.

Frazier & Son has appointed *Irving R. Redland* as assistant to the chief engineer in charge of production and sales. Mr. Redland was formerly manager of the American Radio Hardware Corp.

Chester R. Austin has been promoted to the position of manager of the development section of the Research Dept. of Koppers Co., Inc. He joined Koppers as a ceramic engineering specialist in 1948.

Acheson Colloids Corp. has appointed *Paul L. Eness,* research engineer, to the staff of the company's Products Development Laboratory. Mr. Eness succeeds *D. G. Weaver,* who has been transferred to Acheson's offices in Newark, N. J.

Warren H. Farr, vice president in charge of manufacturing of The Budd Co., will resign from this position Jan. 1, 1951. He will continue as a member of Budd's board of directors, however, and will act as a consultant to Mr. Budd.

The appointment of *Carl E. Scholz* as vice president and chief engineer of All America Cables and Radio, Inc. and The Commercial Cable Co. has been announced. Mr. Scholz has been associated with the International Telephone and Telegraph Corp., parent company of All America, since 1917.

Robert L. Coe was elected to the position of chairman of the board of Chase Brass & Copper Co., Inc. at a recent meeting. *Richard C. Diehl,* former general manager of the Steubenville, Ohio plants of Wheeling Steel Corp., was named to succeed Mr. Coe as president.

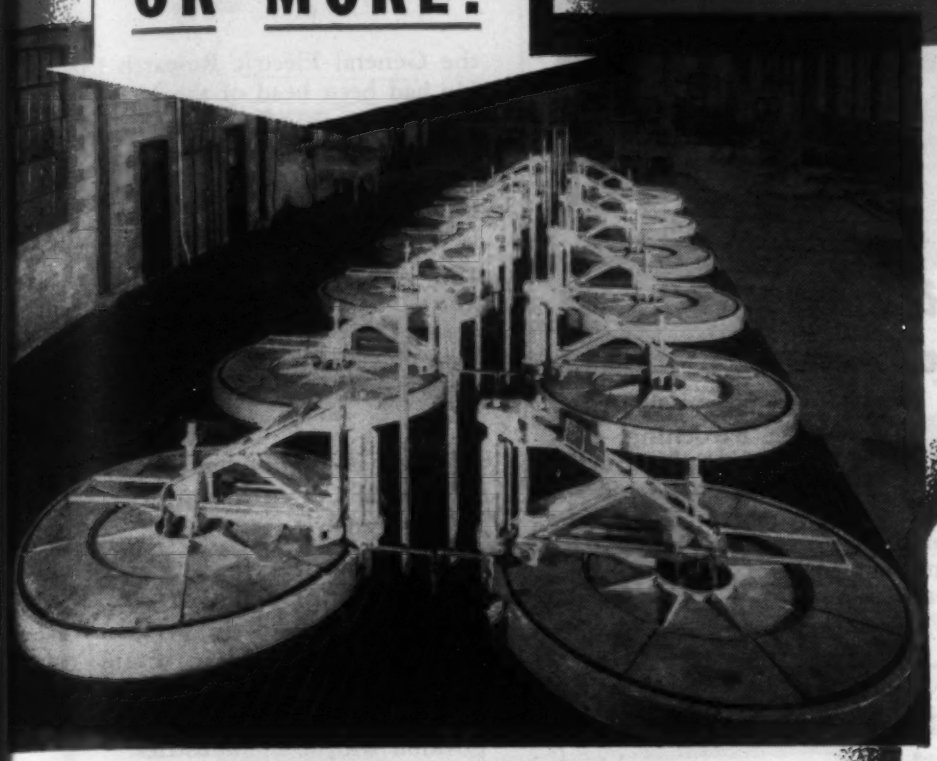
General Electric Co. has made the following announcements: Dr. *James L. Lawson* was appointed manager of the newly formed Electron Physics Divs. of

1-8-16 OR MORE!

'Surface' CONTROLLED ATMOSPHERE . . .

PIT-TYPE FURNACES

. . . in Modern Production Plants



A battery of 16 (12 shown) Pit-Type Furnaces used for carburizing roller bearing parts.

A battery of 8 Pit-Type Furnaces used for carburizing cam shafts in an automotive plant.

Can be used for . . .

- ★ GAS CARBURIZING
- ★ HOMOGENEOUS CARBURIZING
- ★ DRY (GAS) CYANIDING
- ★ CLEAN HARDENING
- ★ BRIGHT ANNEALING

These Features make them OUTSTANDING:

✔ **EXTERNAL OR INTEGRALLY-BUILT RX ATMOSPHERE GENERATOR** • Pit-Type furnaces are used with the various 'Surface' atmosphere generators. For example, an RX Generator may be built integrally with the furnace, or one or more furnaces may be manifolded to a 'Surface' RX, DX, or NX Atmosphere Generator.

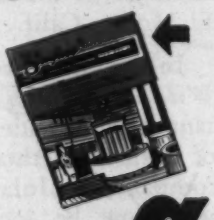
✔ **BASKET OR FIXTURE LOADING** • Small parts can be mass-loaded in a basket and lowered into position in the pit-type furnace. Long, irregular parts may be suspended from a fixture for minimum distortion to parts during heat treatment.

✔ **RADIANT TUBE HEATING** • With the 'Surface' Radiant Tube heating principle, no muffle is required—there's no contamination of the furnace atmosphere with products of combustion — no muffle replacement — more floor space is available—there's economy in operation. 'Surface' Pit-Type Furnaces are built in effective pit sizes up to 4 ft. wide by 8 ft. deep, and larger.

RX, NX AND DX ARE TRADE MARKS OF SURFACE COMBUSTION CORPORATION

'Surface' Pit-Type Furnaces are adaptable to special runs of a diversity of materials and heat treatments. Especially fitted to areas where floor space is limited and size and shape of parts are unusual.

The outstanding performance of the many 'Surface' Pit-Type Controlled-Atmosphere Furnace installations is your assurance of consistent satisfaction.



More complete details are given in this new Bulletin SC-149. Write for your copy today!

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATES: Stein & Roubaix, Paris — British Furnaces, Ltd., Chesterfield

'Surface' INDUSTRIAL FURNACES

FOR: Gas Carburizing and Carbon Restoration (Skin Recovery), Homogeneous Carburization, Clean and Bright Atmosphere Hardening, Bright Gas-Normalizing and Annealing, Dry (Gas) Cyaniding, Bright Super-Fast Gas Quenching, Atmosphere Malleableizing and Atmosphere Forging. Gas Atmosphere Generators.

for *Low Cost* heat treatment of small and medium size parts

The EF chain belt conveyor furnace is one of the most satisfactory continuous heat treating units yet devised for scale-free hardening, carbon restoration and non-decarb heat treating of bolts, chain links, rivets, and other small and medium sized, forged, drawn, stamped, machined, headed and welded parts. Sizes for any capacity requirement. Gas-fired, oil-fired or electrically heated, whichever best suits your particular requirement—and location. Estimates—and samples of heat treated parts—furnished promptly. Write for literature.

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Gas-Fired, Oil-Fired and Electric Furnaces
for any Process, Product or Production

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ALLMETAL'S First Quality

STAINLESS STEEL FASTENERS

IMMEDIATE DELIVERY • ALL TYPES & SIZES

Made right . . .
Priced right . . .
by specialists in stainless!

See Allmetal first for stock shipments of stainless machine, set, self-tapping, wood screws, nuts, bolts, pins, washers, rivets, including Government and "AN" specs. Prompt delivery on various types of Phillips Recessed Head Screws and specials, too.

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STAINLESS STEEL FASTENERS

MANUFACTURERS SINCE 1929
ALLMETAL
Screw Products Co., Inc.
33 GREENE STREET, NEW YORK 13, N. Y.

News Digest

the General Electric Research Laboratory. He had been head of the Nuclear Investigation Divs. *Clifford G. Fick* was named assistant manager of the new divisions. He was formerly head of the Television Div. of the Laboratory. *William N. Oberly* is now assistant to Lisle D. Hodell, manager of manufacturing of G.E.'s Fractional Horsepower Motor Divs. Formerly head of the unit generating section, Unit Equipment Div., Mr. Oberly will now be located at the company's Fort Wayne, Ind. Works.

Egbert A. Cabble has joined The Riverside Metal Co. in the capacity of market research analyst.

Olin Industries, Inc. has announced the appointment of *Robert H. Evans* as executive assistant to the president and executive committee. Mr. Evans resigned from Riegel Paper Corp. as secretary, treasurer and director to accept this new position with Olin Industries.

William L. Batt, Sr., president of SKF Industries, Inc., and former vice chairman of the War Production Board, has been appointed chief of the Economic Cooperation Administration (Marshall Plan) mission to the United Kingdom. Mr. Batt succeeds *W. John Kenney,* who retired in order to re-enter the private practice of law.

Three new vice presidents were named for Kaiser Aluminum & Chemical Corp. and Kaiser Aluminum & Chemical Sales, Inc. They include: *S. S. Inch,* general sales manager of Kaiser Aluminum & Chemical Sales, now in charge of sales; *Thomas J. Ready, Jr.,* assistant general manager of Kaiser Aluminum & Chemical; and *Donald E. Browne,* formerly controller, also named treasurer. *Russell A. Clayton* succeeds Mr. Browne as controller.

Carl Dittmar, manager of the Cleveland district sales office of E. I. du Pont de Nemours & Co.'s Electrochemicals Dept., has retired after serving 48 years in the chemical industry, holding the position of Cleveland manager since 1921. He is succeeded by *Albert R. Tucker,* formerly manager of the du Pont district office in El Monte, Calif.

Inland Steel Products Co. has promoted *William A. Jahn* to the position of assistant to the president. He has been manager of business methods and procedures of the company, an Inland Steel subsidiary, but will now be located at the Milwaukee headquarters.

Almo D. Squitero has joined the Hanson-Van Winkle-Munning Co. as an electrochemist.

The election of *Samuel M. Felton* as president and chief executive officer of Shippers' Car Line Corp., a subsidiary of

with ELECTRUNITE *tubing*

IT'S a kitchen range gas burner venturi tube . . . formerly made of cast iron . . . now brought up-to-date and improved with versatile Republic ELECTRUNITE Tubing. Consider these important facts:

1. Throat and taper dimensions are held to closer tolerance.
2. Injection of gas-air mixture is better—the smooth inside surface of Republic ELECTRUNITE Tubing eliminates frictional resistance.
3. Modern appearance, lighter weight, and easier cleaning make a hit with housewives—help sales.
4. *Manufacturing costs are lower!*

Perhaps Republic ELECTRUNITE Tubing can be profitably put to use in making your products. You'll find it unsurpassed for uniformity, ease of fabrication, and ability to take any form of plating or painting readily and economically. Why not check into its potential for your products—write today to:

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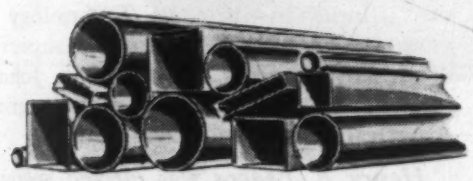
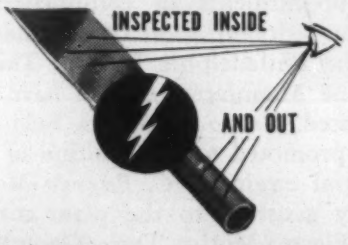
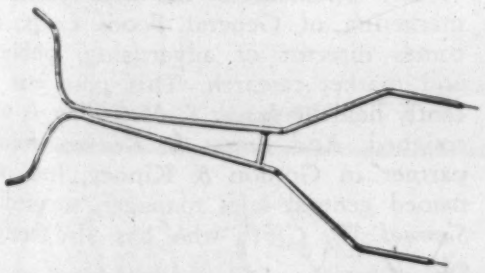
Export Department: Chrysler Building, New York 17, New York



Republic Electrunite Mechanical Tubing is available in a wide range of sizes, gauges, and analyses—in both carbon and stainless steel.



Manufactured by the Republic electric resistance welding process, it is uniformly *high in ductility, surface quality, strength and accuracy of section.*



And for tubing users who do not have complete facilities for fabricating, Republic offers semi or full-fabricated tubular parts. Write for complete information.

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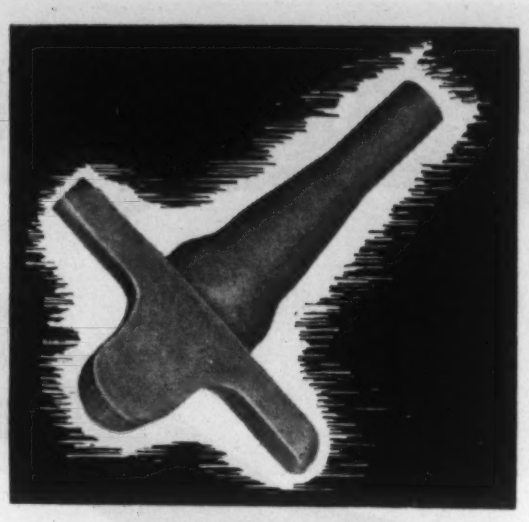
REPUBLIC STEEL ®
ELECTRUNITE TUBING

Better Forgings AT LOWER COST WITH Ajax-Northrup Induction Heating



Single-stroke extrusion of these axle spindles, made possible by scale-free Ajax-Northrup induction heat, provides a continuous stream of 600 forgings per hour for a leading automobile manufacturer.

Pit-free surfaces and superior fibre flow make these extruded forgings *better* . . . fatigue resistance is increased by 17% over hammered forgings. And costs are lowered, because 16 men do the work of 46 . . . virtual elimination of scale and flash saves up to *ten tons* of SAE 1532 bar stock per day . . . floor space requirements are reduced by 80% . . . one single-cavity extrusion die takes the place of two three-cavity hammer dies.

Find out how fast, economical Ajax-Northrup heaters can help *you* to convert to better, more economical forging methods. Send for our technical bulletins today.

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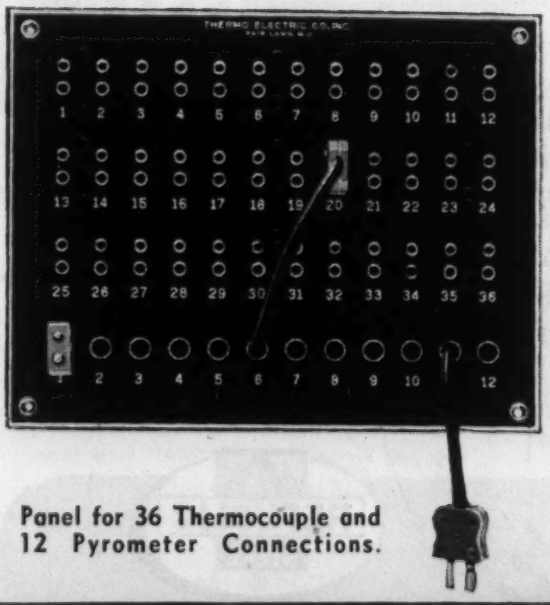
HEATING & MELTING

129

SAVE TIME CONNECTING THERMOCOUPLE CIRCUITS with QUICK COUPLING CONNECTOR PANELS



Panel for 36 Thermocouple and 12 Pyrometer Connections.

A rapid and flexible method for connecting numerous thermocouples to pyrometers —regardless of their location. One central point for making and breaking circuits.

Polarized Plugs and Jacks are made in all standard calibrations—Iron Constantan, Copper Constantan and Chromel Alumel.

Catalog Section 23G fully describes these Panels. Write for your copy today.

Thermo Electric CO., INC.

FAIR LAWN NEW JERSEY

148

News Digest

American Car and Foundry Co., has been announced. Mr. Felton previously served as president of the American Railway Car Institute, and is succeeded by *Charles W. Wright* in this capacity.

Robert P. Desch has joined The Atlas Mineral Products Co. as a research chemist. It was also announced that *George Gabriel*, plant engineer at the Mertztown Plant of Atlas, was promoted to the position of assistant plant manager.

Titanium Pigment Corp., a subsidiary of National Lead Co., has elected *Graham W. Corddry* as vice president in charge of sales. *K. W. Ericson*, formerly Western sales manager of the Corporation, succeeds Mr. Corddry as general sales manager.

Ellis H. Jones has retired as general manager of the Canadian Div. of The Yale & Towne Manufacturing Co. after 57 years of service. *George L. Dirks*, resident consulting engineer, succeeds Mr. Jones as general manager.

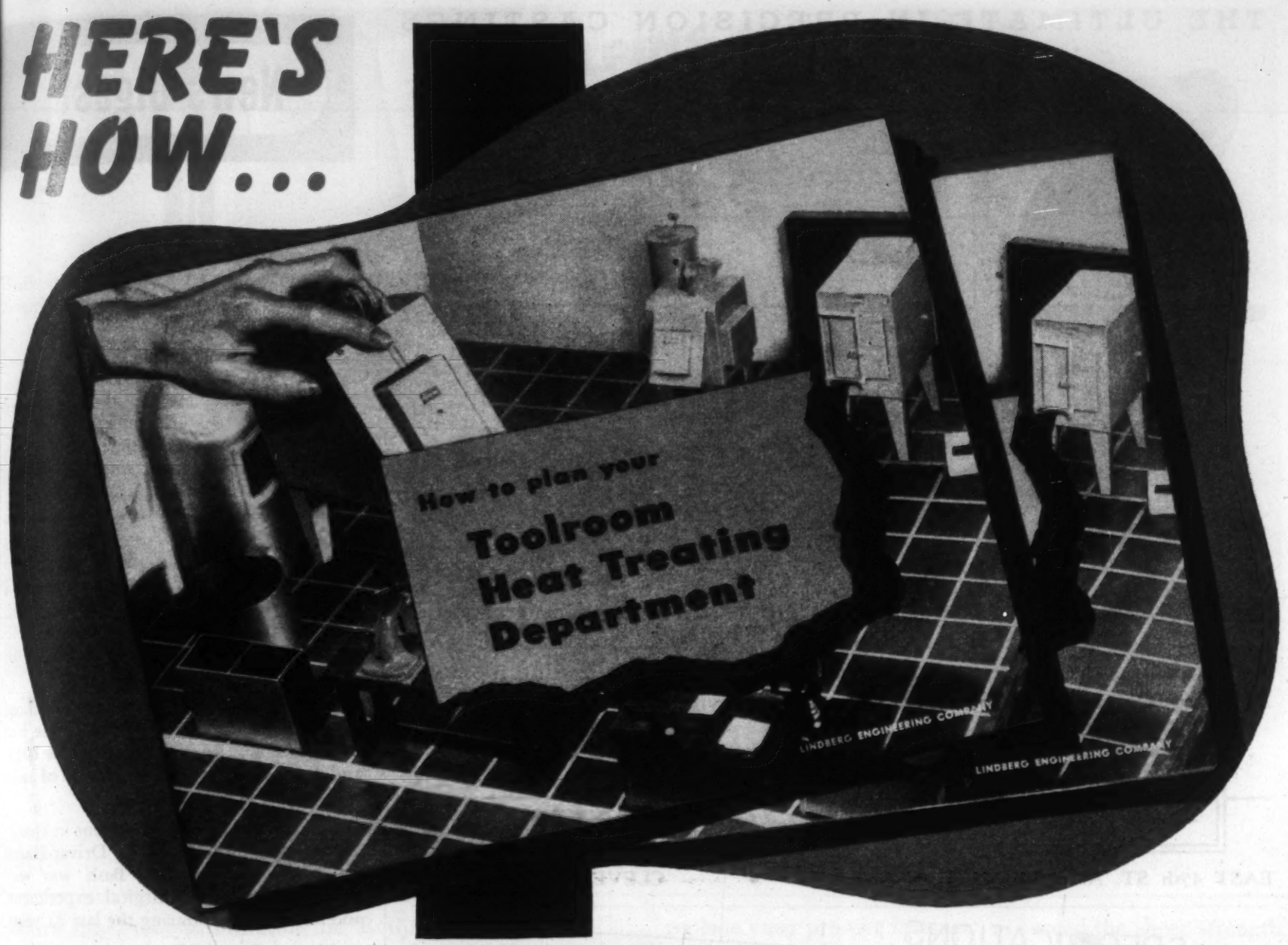
The Armour Research Foundation of the Illinois Institute of Technology has named *Gordon W. Johnson* as supervisor of foundry process research. Mr. Johnson formerly served as chief metallurgist at American Hoist and Derrick Co.

Henry A. Federa was elected secretary, general attorney and a director of the Orinoco Mining Co., a United States Steel Corp. subsidiary. Mr. Federa formerly was an attorney for United States Steel Corp. of Delaware.

Appointments in conjunction with a major reorganization of the management of the Philadelphia Div. of The Yale & Towne Manufacturing Co. have been announced. *Bruno A. Moski*, field engineer, was promoted to the position of chief industrial engineer. *C. Eugene Moore*, formerly assistant to the plant manager of the Electro-Motive Div., General Motors Corp., is now works manager for Yale. *John T. McCarley* was named manager of production. *James A. Shellenberger*, previously assistant to the vice president-marketing of General Foods Corp., becomes director of advertising, publicity and market research. This post was recently held by *James S. McCullough*, who resigned. And *James P. Kinney*, former partner in Gordon & Kinney, Inc., was named general sales manager, succeeding *Samuel W. Gibb*, who has also resigned.

A. R. Kelso has been elected vice president of Mack Trucks, Inc., as well as vice president and a director of Mack Manufacturing Corp., a subsidiary of Mack Trucks. He will make his headquarters at Allentown, Pa. It was also announced that *S. S. Stewart* was named vice president in charge of purchasing for Mack Manufac-

HERE'S HOW...



TO PLAN YOUR TOOLROOM HEAT TREATING DEPARTMENT

Published to assist those planning new or expanded heat treating departments. It's yours for the asking.

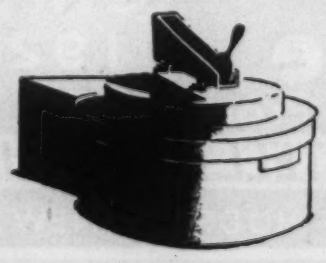
Material contained in this 24 page booklet, prepared by the Lindberg Engineering Company, is based upon years of experience in helping design hundreds of toolrooms . . . plus additional information gained from the 24-hour-a-day operating experiences of the toolroom heat treating department of the Lindberg Steel Treating Company, the world's largest.

It helps arrive at total costs in advance • Shows recommended department layouts • Tells how to select furnaces of proper size • Gives prices of auxiliary equipment such as tongs, quench tanks, straightening presses, hardness testers, work benches, etc. • Contains loose template pages of furnaces, quench tanks, etc. and graph paper . . . a few seconds of scissor work shows you how your department will look.

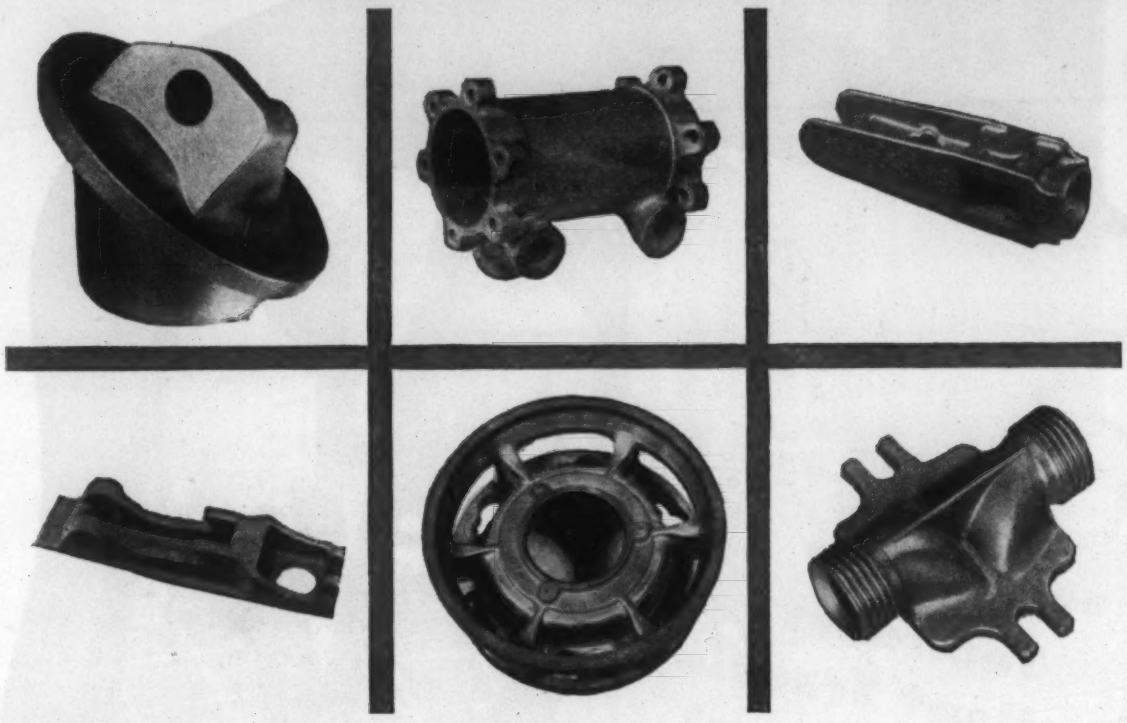
To get your copy write or call your nearest Lindberg Engineering Company office or the Lindberg home office at 2451 West Hubbard Street, Chicago 12, Illinois.

Other helps for Heat Treaters. "Heat Treating Hints"—a publication covering the practical side of heat treating with strictly "how to do it" articles. Available on request.

"Heat Treating Hints", two movies, (color and sound) bring to the screen practical articles from the printed "Heat Treating Hints". Ideal for technical associations, plant showings, schools. Write for Bookings.

LINDBERG  FURNACES

THE ULTIMATE IN PRECISION CASTINGS



These intricate precision castings made from frozen mercury patterns assure you of soundness—accuracy—close tolerances—60-80 micro finish and minimum finishing in size ranges not available by conventional casting methods. All ferrous and non-ferrous metals. Inquiries invited. Brochure on request.

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EAST 45th ST. AND HAMILTON AVE. • CLEVELAND 14, OHIO

News Digest

turing. Mr. Stewart was formerly purchasing agent for the manufacturing division of Air Reduction Sales Co.

Eaton Manufacturing Co. has appointed *Robert F. Golden* as works manager for its Reliance Div. He had been connected with development and research until this promotion. At the same time *C. A. Sellen,* chief metallurgist, was named assistant to the general manager.

George R. Gibbons, one of the pioneers in the development of the aluminum industry and a director of Aluminum Co. of America, died at the age of 71. Mr. Gibbons, who retired as senior vice president of Alcoa on Jan. 1, 1949, began his career with the company in 1901.

The Carpenter Steel Co. has announced the death of *Ransford V. Mann.* He had been associated with Carpenter since 1911, and was vice president in charge of sales at the time of his death.

Francis E. Bash, vice president in charge of the Technical Dept of Driver-Harris Co., died recently. Mr. Bash was well known for his metallurgical experiments and developments during the last 27 years.

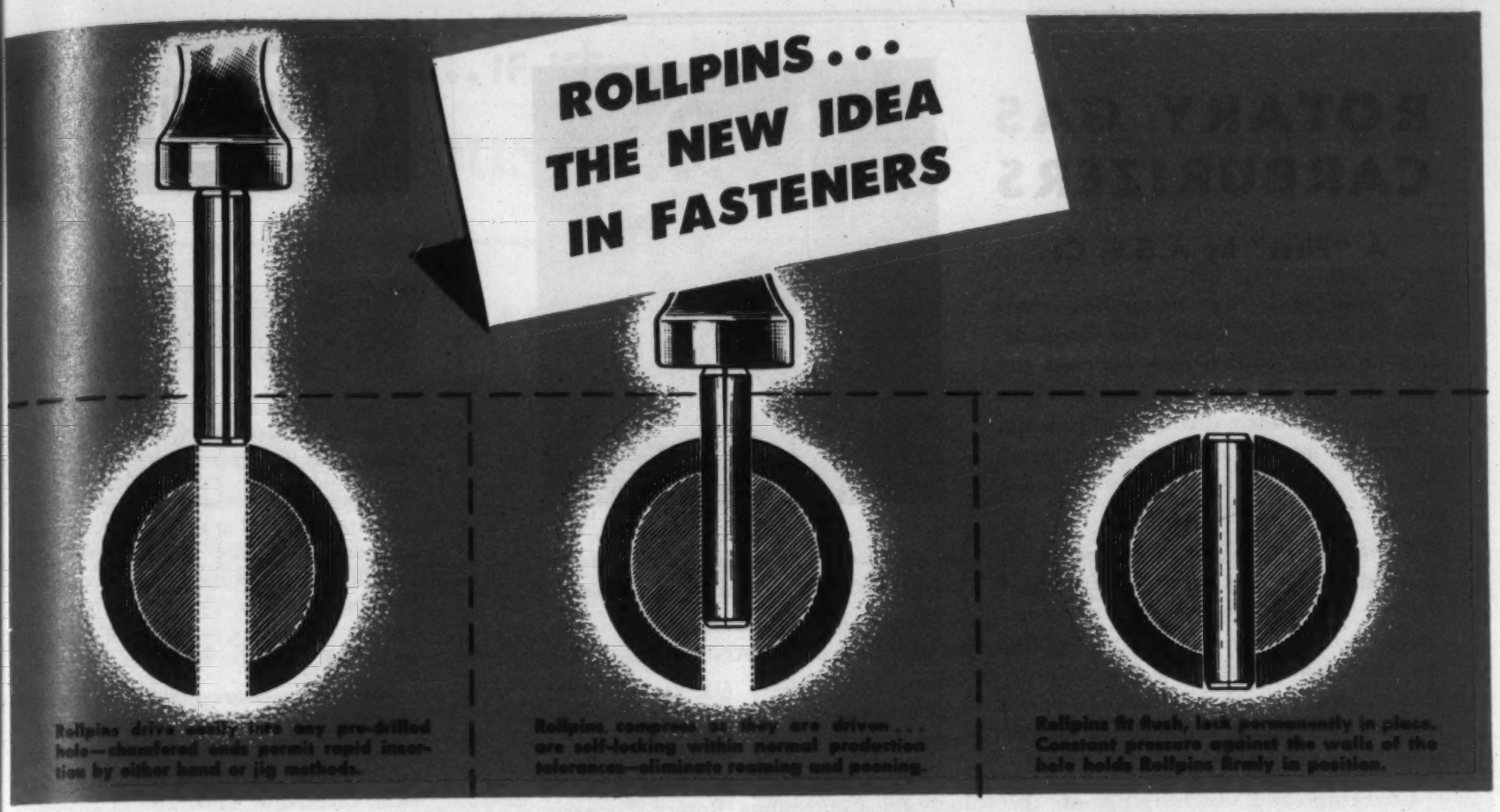
General Electric Co. has announced the death of *Arelin L. Wagoner,* who retired as purchasing agent of steel and steel products on Apr. 1. Mr. Wagoner had served with G.E. for 43 years upon his retirement. Another death affecting G.E. was that of *Earle S. Henningsen,* a pioneer in the development of a.c. machinery. Mr. Henningsen had been manager of engineering of G.E.'s Large Motor & Generator Divs.

Joseph A. Horne, chairman of the board of directors of The Yale & Towne Manufacturing Co., died after a brief illness. He had been associated with Yale & Towne for 58 years.

News of Companies

General Electric Co., Schenectady 5, N. Y., has purchased the patents, name and technical data of the *Turbodyne Corp.,* Hawthorne, Calif., a research subsidiary of Northrup Aircraft, Inc., which has developed a turboprop aircraft engine believed to be the most powerful propeller-type aircraft power plant in the world.

The new plant and office of *Acorn Sheet*


ROLLPINS . . .
THE NEW IDEA
IN FASTENERS
Rollpins drive easily into any pre-drilled hole—chamfered ends permit rapid insertion by either hand or jig methods.
Rollpins compress as they are driven . . . are self-locking within normal production tolerances—eliminate reaming and peening.
Rollpins fit flush, lock permanently in place. Constant pressure against the walls of the hole holds Rollpins firmly in position.

How much can Rollpins save on your production line?

Here's important information on Rollpins—the amazing new fasteners that eliminate slow, expensive reaming, peening, and machining operations. Just imagine the cost-cutting possibilities provided by a single fastener with such wide design and application flexibility that it can replace tapered pins, grooved pins, or straight pins. Investigate the savings Rollpins offer *your* product.

In the short period since their introduction, manufacturers are already using Rollpins as steel fastening pins holding pulleys and gears to shafts; as pivot or hinge pins, clevis pins, cotter keys, shafts, and locating dowels . . . to provide lower-cost, simplified, vibration-proof assemblies.

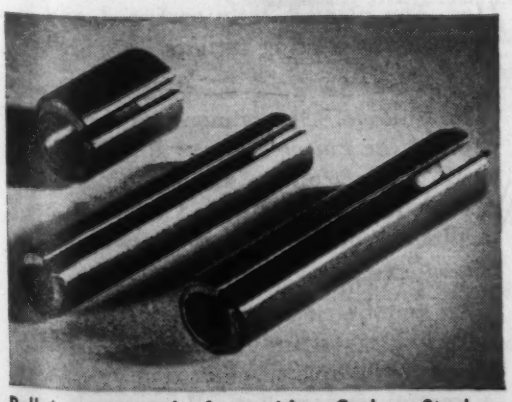
Rollpins require no special installation skills . . . readily replace your present fastener . . . exceed the sheer strength of a cold-rolled pin of equal diameter. Rollpins stay tightly in place until deliberately removed with a pin punch—can be used over and over again.

For complete information on Rollpins and their almost unlimited money-saving applications write to Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

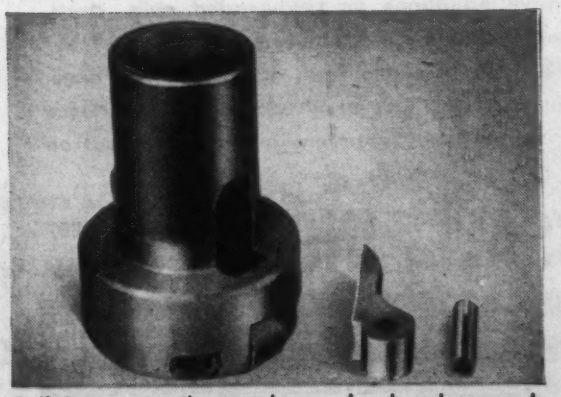
ROLLPIN
A PRODUCT OF

ESNA TRADE MARK

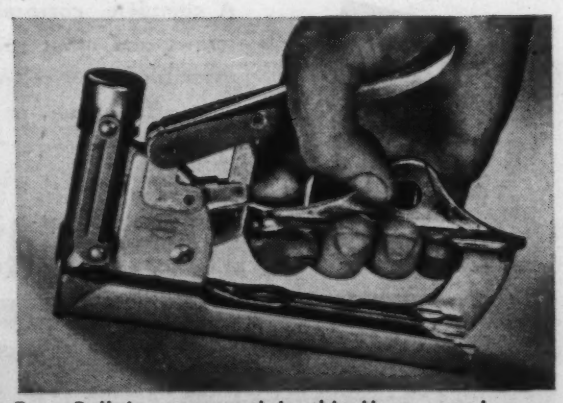
ELASTIC STOP NUT CORPORATION OF AMERICA



Rollpins are made from either Carbon Steel or Stainless Steel and are readily available from stock in diameters from 1/16 inch to ½ inch and in a broad range of standard lengths.



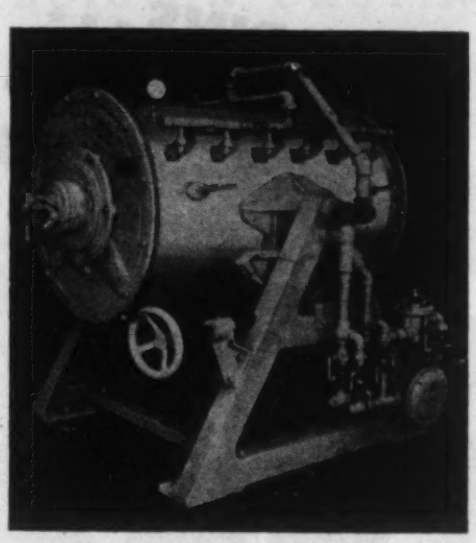
Rollpins are used to replace a hardened, ground tapered pin in this feed tube finger clutch assembly —stand up to flexing and shock more than 2,400 times an hour.



Four Rollpins are used in this Hansen tacker as pivots. Self-retaining, they eliminate headed rivets and bolts . . . simplify maintenance operations . . . provide a flush fit.

ROTARY GAS CARBURIZERS

A "First" by A.G.F. Co.



Versatility is the outstanding characteristic of AGF Rotary Gas Carburizing Furnaces, which may be used not only for carburizing, but also for clean hardening, normalizing, annealing, and other general or atmospheric work without modification to the furnace of any kind.

Uniform heating of the work is assured by the gentle mixing produced by the rotary action of the retort, which is heated by numerous carefully distributed and balanced gas burners. Carburizing or atmosphere gas is introduced through a simply-designed, trouble-free connection.

Charging and discharging of the work is accomplished by means of a tilting feature, which is power-driven on the larger models. The retort remains within the heat at all times.

The furnace shown above is the latest, improved AGF Rotary Gas Carburizer, batch type, with new maintenance-free roller bearing retort support.

AGF gas carburizing equipment also includes Continuous Rotary Furnaces and Vertical Retort Carburizers. Write for literature.

AMERICAN GAS FURNACE CO.

142 SPRING STREET • ELIZABETH, N. J.

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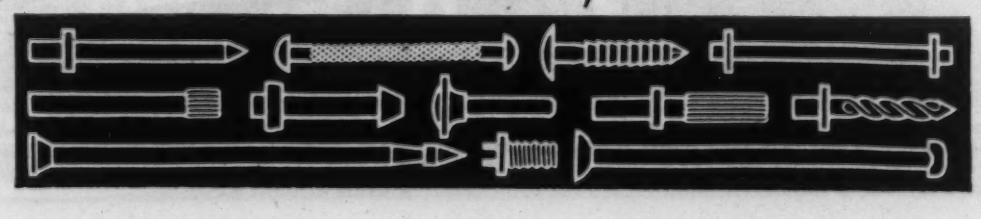
FREE fastener catalog

A complete, comprehensive handbook on cold-headed nails, rivets, screws and other special fasteners. Check on ways to improve your assembly cost-wise, appearance-wise and from a standpoint of maximum effectiveness at minimum cost. One hundred years of experience are at your service. Write for price quotations or for suggestions on the redesigning of your present assembly.

JOHN HASSALL, INC. 162 CLAY STREET BKLYN. 22, N. Y.



News Digest

Metal Mfg. Co., Inc. is now located at 4605-11 W. 21 St., Chicago 50.

The firm name of *Franklin Iron & Metal Co.*, Newark 5, N. J., has been changed to *Franklin Metals Co.*

A new plant which will specialize in the production of plastic and plastic-metal components for the radio, television and lighting industries has been constructed by *Sylvania Electric Products, Inc.* in Warren, Pa. for its Parts Div. L. R. Wanner will be in charge of the new plant.

Need for a larger site for its scheduled $3,000,000 plant for the production of cracking catalysts used by the petroleum industry has caused the *American Cyanamid Co.*, New York 20, to change its plans and locate the plant in Michigan City, Ind. rather than in East Chicago, Ind. The new facilities are expected to be in operation the middle of 1951.

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has purchased the *Big Rock Stone & Material Co.* in Little Rock, Ark. R. S. Wilson, Sr., president of Big Rock, will continue as active head of the company's management. No major changes in operations are contemplated.

Construction of a new plant addition for the production of alkyd plastic molding compounds has been started by the *Plaskon Div.* of *Libbey-Owens-Ford Glass Co.*, Toledo. The new addition will be erected on a site at Plaskon's principal manufacturing location near Toledo, and is expected to be in operation by Mar. 1951.

Cummins Portable Tools Div., Chicago, has purchased the assets of *Fred W. Wappat, Inc.*, Mayville, N. Y. The newly acquired property will be known as the *Fred W. Wappet Div.*, and all personnel and identity of the Wappat Line will be retained.

Due to the increased demand for its industrial precision castings, *Vicon Casting Corp.*, Brooklyn 1, N. Y., has established a new plant at 103 Lombardy St., Brooklyn, to be known as *Omni-Metal Castings, Inc.* The plant is fully equipped, and includes heat treating facilities.

Pullman-Standard Car Manufacturing Co., Chicago 3, has announced the formation of the *Power Ballaster Products Div.*, with manufacturing facilities located at Hammond, Ind. John A. Curtis has been appointed manager of the new division.

Construction of a new building has been announced by *Cummins Engine Co., Inc.*, Columbus, Ind., which will be designated as the Stores Center Bldg. It will be a central storage for all materials and supplies, and will also house quality control and inspection activities and an en-

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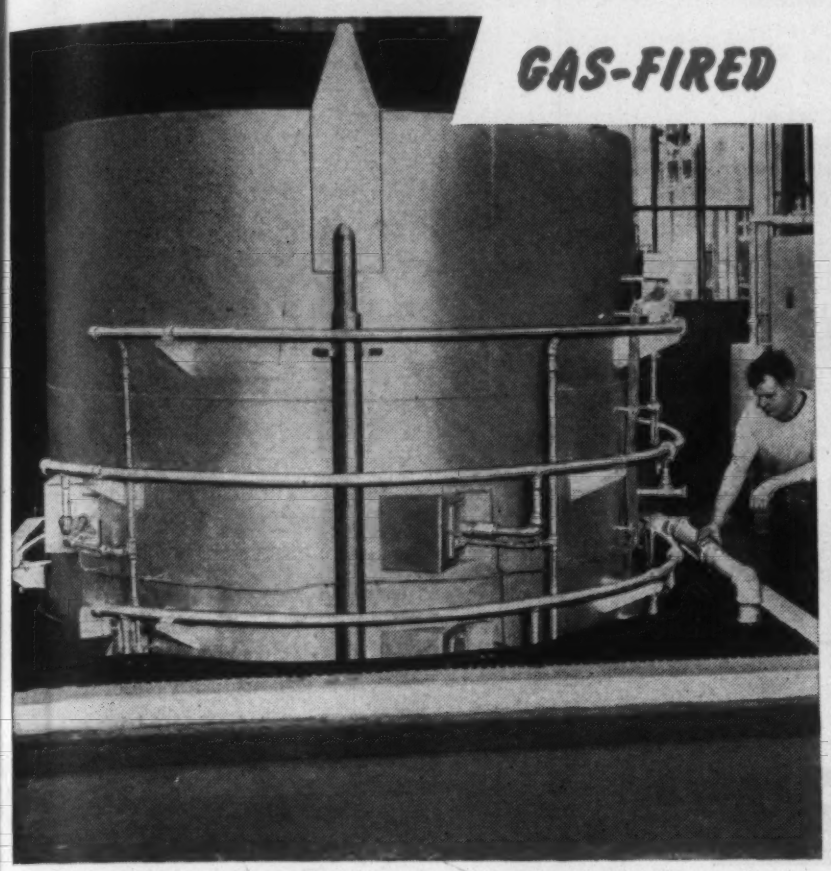
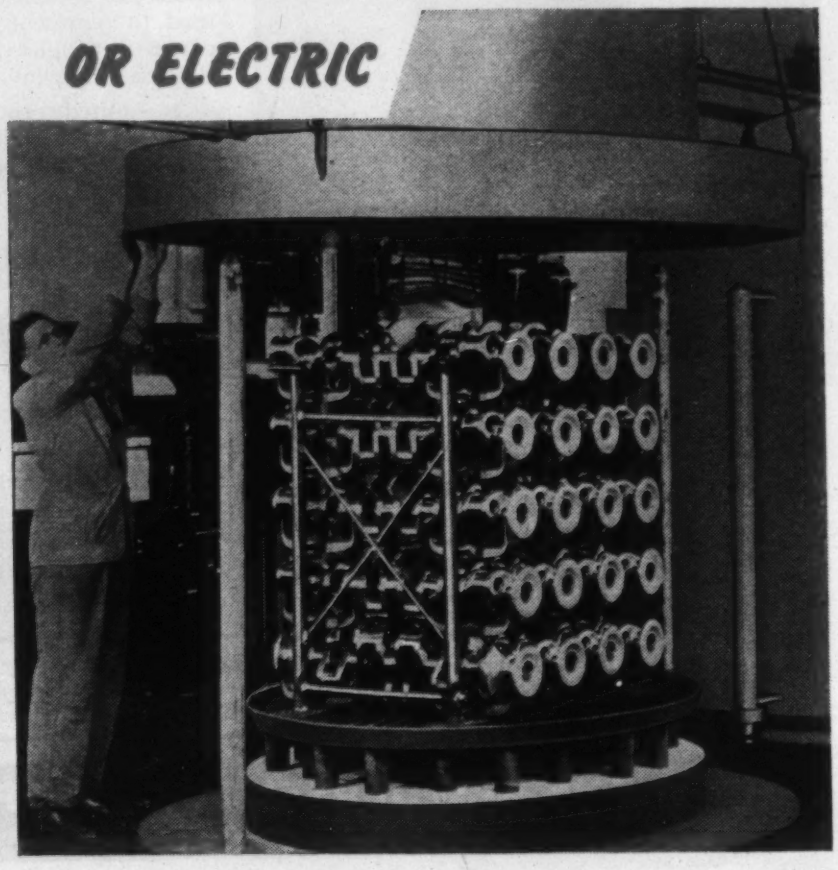


GAS-FIRED



OR ELECTRIC

FOR THE MAN WHO CAN'T BE "SOLD"

Careful buyer? Then, here is help in selecting the equipment to do your job best. You see, Westinghouse makes both electric and gas-fired furnaces, plus the atmosphere equipment that may be required. Thus, Westinghouse engineers have no favorite type of firing or construction to sell. Instead, they study your heat-treating problems with a view toward recommending the equipment to do your job best.

And you can preview results! A well-equipped metallurgical laboratory will sample heat-treat your work and demonstrate the mass production results you may expect.

This unbiased engineering and metallurgical service is called Therm-a-neering. It matches the equipment to your job . . . provides the hundreds of design details that make your heat-treat line run smoothly and economically.

Give Therm-a-neering a chance to help you. You won't have to be sold. You'll know why it's best to buy Westinghouse. Call your nearby Westinghouse representative for details, or write Westinghouse Electric Corporation, 180 Mercer Street, Meadville, Pa. J-10346

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ENGINEERS—Thermal, design and metallurgical engineers to help you study your heat-treating problems with a view toward recommending specific heat-treating furnaces and atmospheres.

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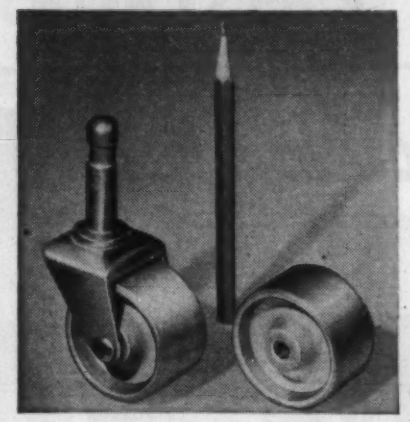
Westinghouse

GAS AND ELECTRIC

Furnaces

Bassick Company Solves Problem of "Problem Casters" for Pianos



Brass piano caster wheels used to represent a procurement problem to The Bassick Company.

As limited production items, they were hard to buy as castings, troublesome to machine from bar stock.

Turning to powder metallurgy, Bassick found the wheels could be readily produced from a Horse Head brass powder—and at a saving of over 30 percent versus outside purchases.

Ordinarily, you think of nonferrous powder metallurgy as a high-speed process that yields its most handsome savings in long runs and in parts especially designed for it.

But in many cases—as with Bassick—you can also use the versatile process as a simple answer to smaller run "problem parts".

LET US SEND YOU A SAMPLE *of a brass powder part to get the "feel" of nonferrous powder metallurgy. At the same time we will be glad to discuss your own individual requirements.*

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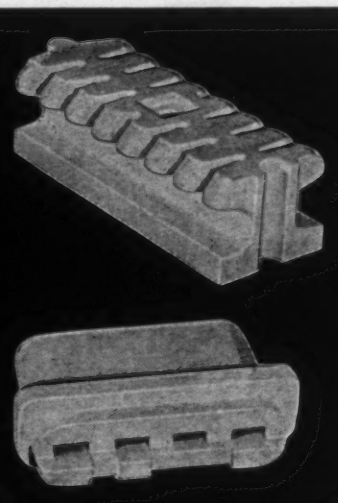

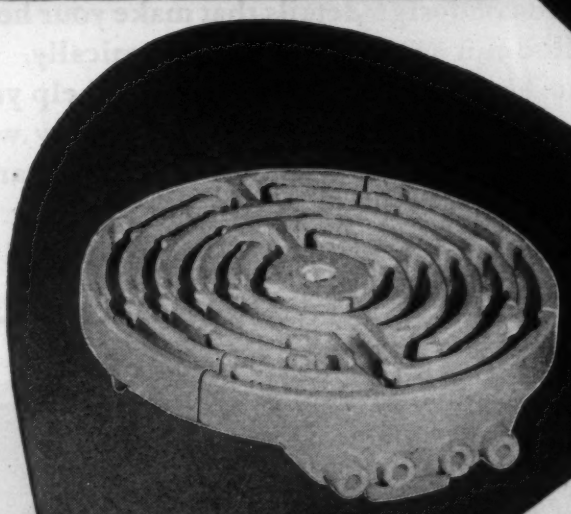

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The STAR PORCELAIN COMPANY

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News Digest

larged department for shipping service parts.

American Cyanamid Co., New York 20, has granted 13 post graduate fellowships and one post doctoral fellowship in the fields of chemistry and chemical engineering for the academic year 1950-51. The following universities were awarded these fellowships: Carnegie Institute of Technology, University of Colorado, Columbia University, Cornell University, Duke University, University of Illinois, Massachusetts Institute of Technology, University of Michigan, University of Notre Dame, Pennsylvania State College, Princeton University, Purdue University, Stanford University, and University of Wisconsin.

Vanadium-Alloys Steel Co., Latrobe, Pa., has appointed *Charles Hardy, Inc.*, New York 17, as sales representatives to handle their line of ferrous alloy steel powders.

The first winner of the Heppenstall Memorial Scholarships, offered by *Heppenstall Co.*, Pittsburgh, Pa., was Donald J. Siegle, son of Elmer Siegle, assistant production manager of Heppenstall's Pittsburgh plant. The scholarship has been established to assist children of Company employes to gain a college education.

The W. W. Sly Manufacturing Co., Cleveland 2, has appointed the *Horrell Co.*, Los Angeles 46, to act as sales engineers for the Sly line of industrial dust control and sandblast equipment.

A contract has been awarded *Minnesota Mining & Manufacturing Co.*, St. Paul 6, Minn., as agents for the federal rubber reserve agency, and *Pacific Rubber Co.*, as associates, to re-activate and operate a $22,000,000 government-owned synthetic rubber plant at Torrence, Calif.

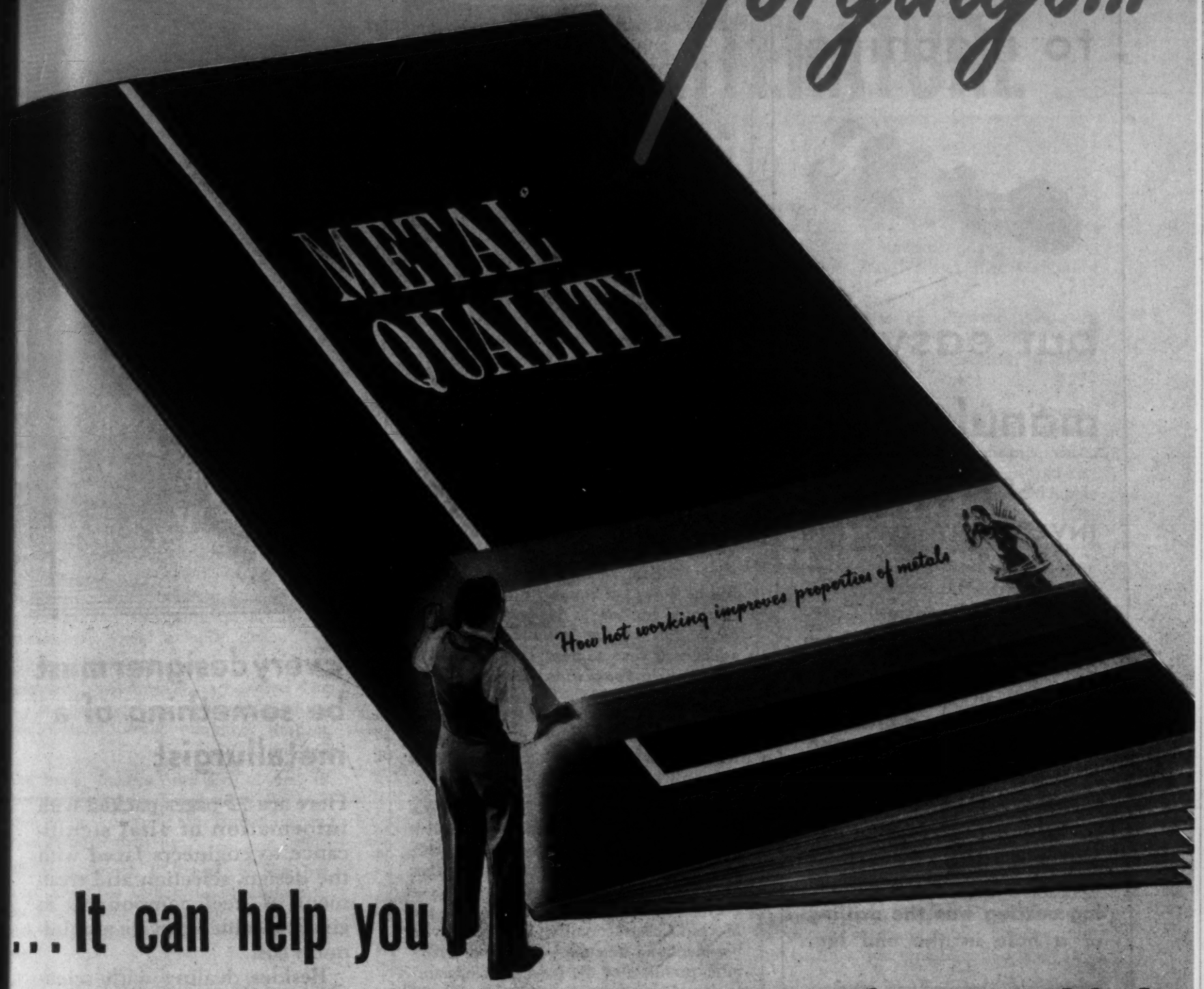
The Budd Co., Philadelphia, has been awarded a citation by the Chamber of Commerce in recognition of the Company's contribution to the industrial development of the community by recently completing a new foundry, located adjacent to Budd's Red Lion plant in Northeast Philadelphia.

A fellowship for $3500 has been established at Rensselaer Polytechnic Institute by the *Aluminum Co. of America*, New Kensington, Pa. Holder of the fellowship has not yet been named.

News of Societies

The *Association of Iron and Steel Engineers* elected officers for the coming year

this REFERENCE BOOK on *Forgings...*



...It can help you reduce cost at the point of assembly!

There are thousands of instances where forgings have reduced the cost of parts at the point of assembly. This booklet containing 60 pages of authoritative information on forgings formed to close tolerances by the use of closed impression dies tells how cost of reductions may be obtained. Forging production techniques are described and illustrated.

Forgings provide rapid assembly of complex parts by welding adaptability of widest range; forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses; forging to shape avoids waste of metal and reduces machining and finishing time-cost. The metal quality and cost-reducing possibilities obtainable in forgings cannot be equalled or duplicated.

Recheck every stressed part in your equipment, as well as simple handles and levers, and consult a forging engineer about possibilities for reducing costs at the point of assembly. Only a forging engineer can inform you fully regarding the numerous advantages obtainable with forgings. Your copy of this reference booklet on forgings is available now. Attach coupon to your business letterhead.

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Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metals" 1949 Edition.

Name ..... Position .....

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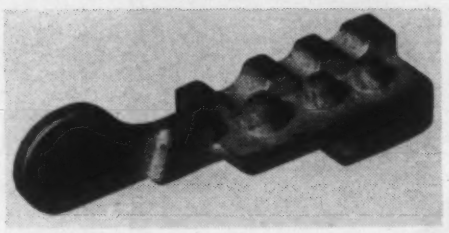
Company .....

Impossible* to machine



but easy to manufacture

. . . AS A PRECISION INVESTMENT CASTING

Engineered Precision Casting Co. solved the above production dilemma with a precision investment casting. The part is a crimping jaw. The material AISI-4140 heat treated steel. Note the reentrant slot on the bottom surface and the grooves and bosses on the top surface. The only operation following casting was the drilling of a hole in the end lug.

* Impossible to machine from one piece economically.

Use this coupon . .

For further information on the above and other manufacturing problems solved by precision casting, use this coupon or write.

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ENGINEERED PRECISION *Casting* CO.
MATAWAN, N. J.

News Digest

at their recent convention. John F. Black, assistant general superintendent, Youngstown Sheet and Tube Co., succeeds A. S. Glossbrenner as president. Mr. Glossbrenner will continue to serve on the board of directors. I. N. Tull, electrical superintendent of the Republic Steel Corp., was named first vice president. John L. Young, vice president in charge of engineering, National Tube Co., became second vice president. The new treasurer is E. L. Anderson, electrical superintendent, Bethlehem Steel Co. And John E. Vohr, general superintendent, Carnegie-Illinois Steel Corp., was elected as secretary.

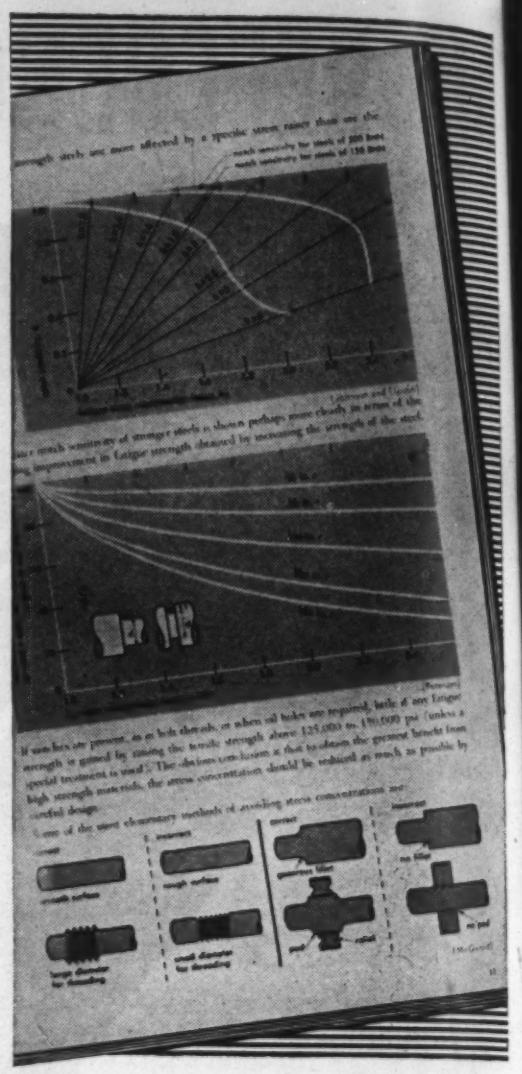
Dr. William R. Osgood, materials engineer of the National Bureau of Standards, has been named director of the department of mechanics at the *Illinois Institute of Technology*. At the same time, Albert Litvin, another materials engineer for the Bureau of Standards, was appointed structural engineer at the *Armour Research Foundation* of the Institute. It was also announced that a grant of $5,000 from the *Wunsch Foundation* was made to the Institute, to establish a Silent Hoist and Crane Co. Materials Handling award, to be presented annually to the students writing the best papers on the subject of materials handling.

New officers for the *National Metal Trades Assn.* were elected at the recent annual convention. They include: president—Joseph L. Kopf, president of Jabez Burns & Sons, Inc.; first vice president—Phillip M. Morgan, president of the Morgan Construction Co.; and second vice president and treasurer—Charles S. Craigmile, president of the Belden Manufacturing Co. During the same meeting, Harold S. Falk, president of the Falk Corp., was named to receive the Association's Industrial Relations Achievement Award, presented to the American citizen whose contributions in the field of industrial relations are deemed most important.

The *Steel Founders' Society of America* is sponsoring an award program for the best papers on parts or products which can be made advantageously as steel castings, or new applications or uses for steel castings. The contest is open to all persons except employees of the Steel Founders' Society and of companies that are members of the Society. Entries must be postmarked not later than midnight, Dec. 1, 1950, and should be sent to Award Committee, Steel Founders' Society of America, 920 Midland Bldg., Cleveland 15.

During the annual meeting of the *American Die Casting Institute,* the following officers were elected: president,

(Continued on page 164)



Every designer must be something of a metallurgist

Here are 72 pages packed with information of vital significance to engineers faced with the design, selection and treatment of steel components to give a specified service at minimum cost.

Besides dealing with scientific design, the book gives important metallurgical data, all compiled from the designer's viewpoint. Free on request.

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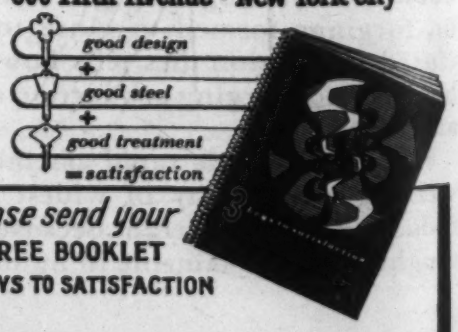

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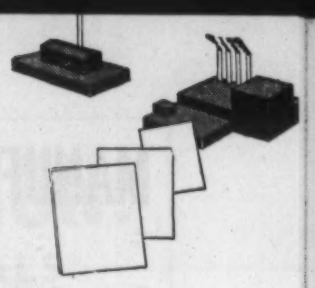

MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Stainless Steel Design. Allegheny Ludlum Steel Corp. New book discusses in detail applications of high tensile stainless steel in structural design. (1)

Steel Design. Climax Molybdenum Co., 72 pp. Booklet tells how to combine good design, high quality steel and proper treatment for best results with steel components. (2)

Abrasion Resistant Alloy. Jones & Laughlin Steel Corp., 36 pp., ill., No. AD 155. Applications in mining, quarrying and earthmoving of Jalloy, abrasion and impact resistant steel. Gives technical data. (3)

Steel Bars. La Salle Steel Co. Describes Stressproof, cold-finished, carbon-steel bars said to combine high strength, machinability, wearability and minimum warpage. (4)

Clad Steels. Lukens Steel Co., 2 pp., ill. Describes five types of clad steels, and indicates savings possible on chromium and nickel through their use. (5)

Alloy Steel. Joseph T. Ryerson & Son, Inc., 2 pp. Describes Ledloy, lead-bearing open hearth steel said to machine 30 to 50% faster than fastest previously available screw steel. (6)

Alloy Steels. Wheelock-Lovejoy & Co., Inc., 3 pp. Data on AISI, Hy-Ten and SAE alloy steels, including composition limits, heat treating instructions, physical properties and applications. (7)

Nonferrous Metals

Plated Metals. American Nickeloid Co., ill. Indicates wide variety of economies available to users of pre-plated metals for parts manufacture. (8)

Low Melting Alloys. Cerro de Pasco Copper Corp. Technical data on Cerro (low temperature melting) alloys and special applications useful in many phases of manufacturing. (9)

Spring Alloys. Elgin National Watch Co., Industrial Products Div., 2 pp. Composition, properties and applications of Elgiloy, cobalt-chromium base spring alloy. (10)

Tungsten and Molybdenum. Fansteel Metallurgical Corp., 24 pp., ill., No. F-1019. Description, chemical and mechanical properties, and details of such uses as heating elements, electronic tube parts and cooling coils. (11)

Aluminum Alloy. Frontier Bronze Corp., 24 pp., ill. Detailed technical data on Frontier 40-E Aluminum Alloy, high strength, natural aging alloy. Includes applications. (12)

Welding Nickel Alloy. Illium Corp., 4 pp., No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base, corrosion resistant alloy. (13)

Electrical Resistance Alloy. The C. O. Jelliff Mfg. Co., 6 pp. Engineering data on Jelliff Alloy 1000, electrical resistance alloy said to have outstanding mechanical and electrical properties. (14)

Babbitt Metal. National Bearing Div., American Brake Shoe Co. Booklet gives complete data on specification, melting and pouring of babbitt for use in bearing manufacture. (15)

Nonferrous Alloy Specifications. The Riverside Metal Co. Data sheets correlate ASTM, Federal, Army and Navy Specifications for 40 nonferrous alloys. Includes characteristics, available forms and uses. (16)

Nonmetallic Materials • Parts

Plastic Moldings. Accurate Molding Co. Describes facilities for producing precision plastic moldings. Case histories given. (17)

Felt Parts. American Felt Co., folder, ill. Describes custom-made cut felt parts with applications including separating, protecting, sealing, polishing and insulating. (18)

Hard Rubber and Plastics. American Hard Rubber Co., 60 pp., ill. Complete technical data on all grades of Ace hard rubber and plastics. (19)

Ceramic Parts. American Lava Corp., chart. Shows properties of Al-Si-Mag ceramics used in custom making uniform, dimensionally accurate, economical parts. (20)

Phenolic Resins. The Borden Co., Chemical Div. Catalog describes wide range of Durite phenolics available for general purpose, heat and electrical resistance parts. (21)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 161

Precision Molded Plastics. Consolidated Molded Products Corp., 8 pp., ill. Describes facilities and equipment for producing compression-, transfer- and injection-molded plastics. (22)

Plywood. Douglas Fir Plywood Assn., 32 pp., ill. Series of articles shows how to use plywood effectively in fixtures, displays, posters and signs. (23)

Plastic Lined Fittings. The Dow Chemical Co., 32 pp., ill., No. SL6-N-250. Catalog of Saran lined steel and iron pipe valves and fittings and Saran spacers and gaskets. Includes properties, design data and applications. (24)

Plastic Machine Parts. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept. Discusses such wide industrial uses for nylon as gears, bearings and machine parts. (25)

Flexible Tubing. Flexible Tubing Corp., 8 pp., ill., No. 5-4. Applications and performance data on Spiratube flexible tubing for ventilation and materials conveying. (26)

Laminated Plastic Parts. The Formica Co. Catalog gives full information on company's facilities for complete machining of Formica custom made parts. (27)

Polyvinyl Plastics. B. F. Goodrich Chemical Co., 16 pp., ill. Properties and descriptions of Geon resins. Detailed applications as extrusions, wire and cable, flooring, films and coatings, and molded products. (28)

Polyvinyl Resin. B. F. Goodrich Chemical Co. Technical data on Geon, versatile heat-, weather-, wear- and chemically-resistant resin available in various transparencies and forms. (29)

Plastic Molding. The Grigoleit Co. Folder describes this company's facilities for producing molded plastics. Includes designing, engineering, tooling, molding and finishing. (30)

Corrosion Resistant Nonmetallics. Haveg Corp., 8 pp., ill. Detailed data on Haveg, special resin and asbestos corrosion resistant material. (31)

Thermosetting Plastic. Houghton Laboratories, Inc., 4 pp., No. 601. Specifications, properties and applications of Hysol 6000, a thermosetting plastic especially adapted to chemical and electrical uses. (32)

Handling Phosphoric Acid. Monsanto Chemical Co., Phosphate Div., 8 pp. Equipment specifications and procedures for the safe handling of 75% phosphoric acid in quantity. (33)

MANUFACTURERS' LITERATURE

Carbon Products. Morganite, Inc., 8 pp., ill., No. 14. Specifications of various carbon bearings and bushings. Also, properties of six series of Morganite carbon products. (34)

Plastics Forms. Rogers Corp., 12 pp., ill. Shows two series of molded forms, including molding boards, laminated sheets and punchings, and preshaped preforms. (35)

Cast Acrylic Sheet. Rohm & Haas Co., Plastics Dept., 5 pp., No. 68. Properties, fabrication and forming information, and applications of Plexiglas II, a heat resistant plastic adapted to weathering. (36)

Cellular Rubber. Rubatex Div., Great American Industries, Inc., No. RBS-12-49. Catalog describes Rubatex closed cell rubber designed for cushioning, gasketing, shock-absorbing or damping applications. (37)

Organic Solvents. The Solvents and Chemicals Group, 64 pp. Entitled *Organic Solvents,* discusses terms used in tables of properties of organic solvents, lists the solvents and their applications, and gives detailed tables of properties of hydrocarbon solvents, alcohols, esters, ketones and chlorinated solvents. (38)

Sponge Rubber. Sponge Rubber Products Co., 12 pp., ill. Describes Spongex products, including sheet sponge rubber, die cut shapes, cord, tubing, molded forms and pad stock. (39)

Colored Rubber. Stalwart Rubber Products Co., 4 pp., ill. Outlines company's facilities for giving rubber any desired color or shade without changing other characteristics. (41)

Technical Plastics. Synthane Corp., 20 pp., ill., No. 16/15. Properties, available forms, specifications and applications of this company's technical plastics described. (42)

Rubber Parts. Tyer Rubber Co., 4 pp., ill., No. 1c. Describes design and molding service for rubber parts specified by industry. (43)

Carbon-Graphite Parts. U. S. Graphite Co., 68 pp., ill., No. G-49. Detailed properties, chemical resistance, assembly information, design aids, 60 applications and limitations of Graphitar. (44)

Polyvinyl Resins. U. S. Rubber Co., Naugatuck Chemical Div., 20 pp., ill. Detailed properties, ingredients, compounding and processing of Marvinol polyvinyl chloride resins. (45)

Plastics Parts. Watertown Mfg. Co., 44 pp., ill. Complete data on properties and applications of plastics produced by this company. (46)

Metal Parts • Forms

Quality Castings. Abrasive Alloy Castings Co., 4 pp., ill., No. 30M. Describes Ni-Resist cast irons, said to have unusually good properties, enable high-grade castings. (47)

Zinc Alloy Dies. Allied Products Corp., Richard Bros. Div., 4 pp., ill., No. W-35-950. Describes Allite zinc alloy dies for temporary production to test new forms, while repairing permanent dies. (48)

Aluminum Impact Extrusions. Aluminum Co. of America, 2144-J Gulf Bldg., Pittsburgh 19, Pa. Shows advantages and wide range of shapes available with impact extruding. Write Alcoa directly.

Aluminum Parts. Aluminum Goods Mfg. Co., 56 pp., ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (49)

Bronze Castings. American Non-Gran Bronze Co., 16 pp., ill. Describes production of, and facilities for producing precision bronze castings. Shows number of typical products. (50)

Cast Parts. Microcast Div., Austenal Laboratories, Inc., 16 pp. Details of Microcast Process for casting intricate shapes to close tolerances from hard-to-form alloys. Gives many applications. (51)

Metal Tubing. B & M Manufacturing Co., 4 pp., ill. Shows Spiralock tubing, a versatile low cost, high strength tubing in numerous special forms, sizes and metals. (53)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp., ill. Advantages and specifications of mechanical tubing. Lists such applications as construction equipment and mechanical pencils. (54)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pp., ill. Physical properties, corrosion resistance and available sizes of this company's stainless steel tubing. (55)

Steel Castings. Continental Foundry & Machine Co., 32 pp., ill. Booklet presents 12 considerations that should be taken into account in buying steel castings. (57)

Magnesium Die Castings. Doehler-Jarvis Corp., 4 pp., ill. Physical properties, applications and advantages of Doler-Mag magnesium die castings. (58)

Metal and Plastics Parts. The Electric Auto-Lite Co., Bay Manufacturing Div., 16 pp., ill. Shows a wide variety of custom made ornamental and functional metal and plastics parts. (59)

Chromium-Nickel Castings. Electro-Alloys Div., American Brake Shoe Co., 60 pp. Properties, specifications and applications of cast 16 chromium-35 nickel alloys. (60)

Investment Castings. Engineered Precision Casting Co., 4 pp., ill. Describes Epco Precision Investment Castings. (61)

Stainless Tubing. Peter A. Frasse & Co., 12 pp. Data on machining seamless mechanical tubing, including recommendations for tool design. (63)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp., ill. Properties and advantages of Graphalloy grades for bushings and electrical uses. Bearing design data included. (64)

Precision Castings. Gray-Syracuse, Inc., pp., ill. Various parts of precision-ca brass, bronze, beryllium, copper and ste described. (65)

Zinc Die Castings. Gries Reproducer Corp 4 pp., ill. Detailed specifications of corr sion resistant nonferrous zinc alloy wi nuts, small zinc die castings and injecti moldings. (66)

Helical Compression Springs. Instrume Specialties Co., Inc., 2 pp., ill. How obtain economical assortment of 100 ber lium copper compression springs for dev opment work. (67)

Containers for Bromine. The Internation Nickel Co., Inc., 8 pp., ill., No. 16 M reprint. Describes bromine corrosion tes and their results. Indicates proper materia for use in containing bromine. (68)

Bearing Design. Johnson Bronze Co. Set o data sheets gives detailed information an considerations necessary to good bearin design. (69)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Details on properties o Kaiser Aluminum ACSR and All-Aluminum Cable. Gives available reel sizes. (70)

Cemented Carbide. Kennametal, Inc., 2 pp ill., No. 284. Performance reports on hig temperature tubing of Kentanium K140A a cemented titanium carbide. (71)

Aluminum Extruded Shapes. Light Metal Corp., 6 pp., ill. Shows facilities for pro ducing to order a variety of indicated alu minum fabrications and extruded shapes. (72)

Die Castings. Madison-Kipp Corp., 32 pp ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather weight air grinder and Fresh Oil lubricators (73)

Iron Castings. Meehanite Metal Corp., 4 pp., ill., No. 32. Detailed tabular summary of physical properties of Meehanite high quality gray iron castings. (74)

Alloy Castings. Michiana Products Corp., 16 pp., ill., No. 112. Properties of Michiana heat, corrosion and abrasion resistant and special purpose alloys for castings of wide applications. (75)

Screw Machine Parts. Mueller Brass Co., 6 pp., ill. Shows brass, bronze and copper custom made screw machine parts available, and lists other nonferrous products. (76)

Nonferrous Powder Parts. The New Jersey Zinc Co. Fourteen case histories indicating properties and uses of nonferrous powder metals and economies obtained in their use. (77)

Zinc Alloy Die Castings. The New Jersey Zinc Co., 28 pp., ill. Applications and principal features of Zamak-3 and Zamak-5 zinc alloy die castings. (78)

Stainless Steel Castings. The Ohio Steel Foundry Co., 4 pp., ill., No. FC-350. Shows numerous stainless castings, and gives specifications of Fahrite stainless steel grades. (79)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp., ill. Describes Phoe-

MANUFACTURERS' LITERATURE

48-WP. Catalog of Talide dies and wear parts for such uses as blanking, extrusion, spinning and swaging, said to outwear steel dies. (144)

Injection Molding Machine. Reed-Prentice Corp., 4 pp., ill. Complete specifications and features of company's 10J-60-oz. plastic injection molding machine. (145)

Foundry Blowers. The Spencer Turbine Co., No. 112. Describes simple, light weight, all metal blowers for foundry air supplies. Said to require little maintenance. (146)

Inspection • Testing • Control

Thickness Gage. Ferro Enamel Corp. Details on pocket-size thickness gage, enabling measurement of nonmagnetic coatings on ferrous surfaces. (147)

Batch Mixer for Testing. Claud S. Gordon Co. 1 p., ill. Describes 4-qt. stainless steel batch mixer for thoroughly mixing small amounts of sample mixtures for test purposes. (148)

Microphotometer. Jarrell-Ash Co., No. 1-5. Specifications for Jaco projection comparator microphotometer with many advantages to the spectrographer. (149)

Brinell Hardness Tester. Steel City Testing Machines, Inc., 2 pp., ill., No. M450. Describes Model UK-300-M hardness tester for medium production rates and easy operation. (151)

Thermocouple Connectors and Panels. Thermo Electric Co., Inc., 4 pp., ill., No. 23. Describes coupling connectors for thermocouples, including plugs and jacks and quick coupling connector panels. (152)

Temperature Controls. Wheelco Instruments Co., 4 pp., ill., *Wheelco Comments*, Vol. 9, No. 3. Temperature control instrument to increase capacity of wire patenting process. (153)

General

Calculator. Wales-Strippit Corp. Free slide rule type of calculator enables rapid determination of cost and time of each part and whole run on Wales Fabricator. (154)

Tube Mills. The Yoder Co., 65 pp., ill. Pros and cons of operating a tube mill, plus detailed information on the process. Also technical data on standard and other equipment. (155)

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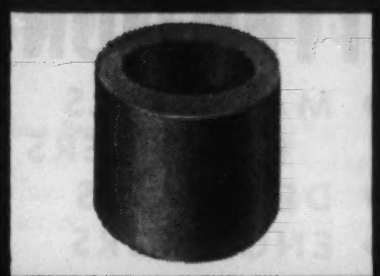

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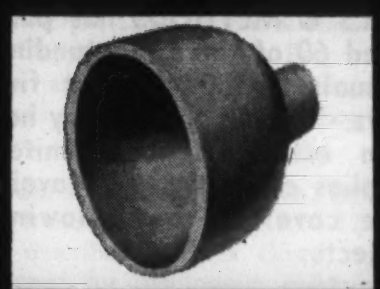

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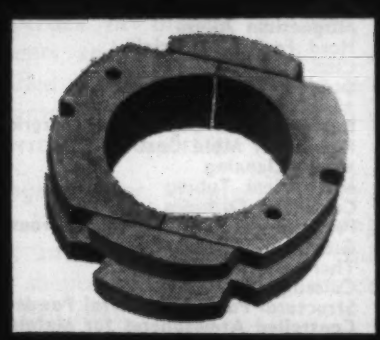

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News Digest

Austin T. Lillegren; vice president, G. M. Rollason; secretary, David Laine; and treasurer, W. J. Parker.

To assist manufacturing concerns in the organization of their standardization work, a private five-day seminar will be held Jan. 22-26, 1951, at the Engineering Societies' Bldg., New York City. The lecturer will be Dr. John Gaillard, mechanical engineer, *American Standards Assn.* For details and registration, write Dr. Gaillard at 400 W. 118 St., New York 27.

The newly organized *Bituminous Coal Operators Assn.* elected the following officers at a recent meeting: president—Harry M. Moses, president of H. C. Frick Coke Co. and associated companies; and secretary-treasurer—Joseph G. Chromis, secretary and administrative assistant to Mr. Moses. The board of directors consists of the chief executives of member companies. Headquarters for the new organization is in the World Center Bldg., 16 and K Sts., N.W., Washington, D. C.

An award of merit has been presented to Donald Beggs, development engineer of Surface Combustion Corp., by the *Mines Experimental Station* of the *University of Minnesota,* in recognition of his significant contribution in the utilization of low-grade iron ore (taconite).

An 18-point program of plant maintenance technique has been planned for discussion during the first three days of the *Plant Maintenance Show,* scheduled to be held Jan. 15-18, 1951, at the Public Auditorium in Cleveland. Four general sessions will be held for all visitors, and eight sectional conferences for executives and engineers with specialized problems. Advance registration cards and hotel information may be obtained from Clapp and Poliak, Inc., 341 Madison Ave., New York 17.

The Wet Ground Mica Assn. has made a new grant to the Research Div., *New York University College of Engineering,* to cover a 12-month extension of the project on use of wet ground mica in organic coatings. The project is under the direction of Dr. Max Kronstein, adjunct associate professor of chemical engineering.

The first motion picture telling the story of malleable iron—This Moving World—is sponsored by the *Malleable Founders' Society* and is available free of charge from *Association Films, Inc.* The three-reel, 16-mm. technicolor film shows how the metal is made, tested and used. The film may be borrowed from any one of the following Association Films exchanges: 35 W. 45 St., New York City; 206 S. Michigan Ave., Chicago; 351 Turk St., San Francisco; and 1915 Live Oak St., Dallas, Tex.

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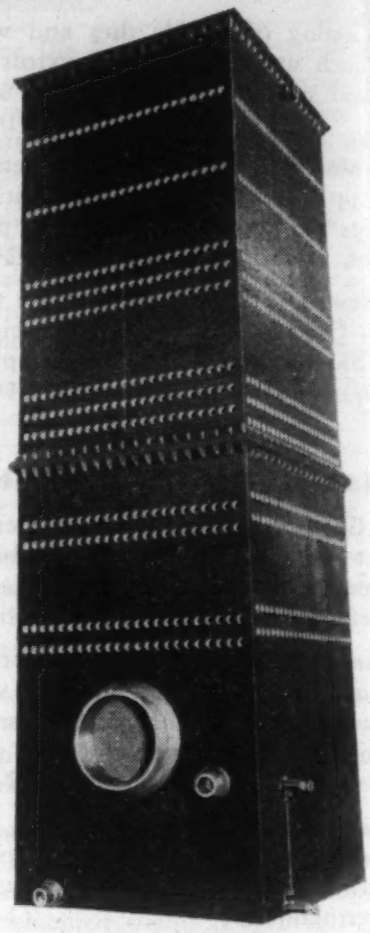

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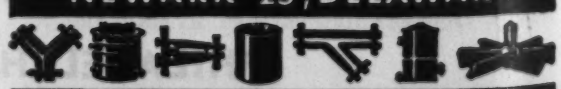

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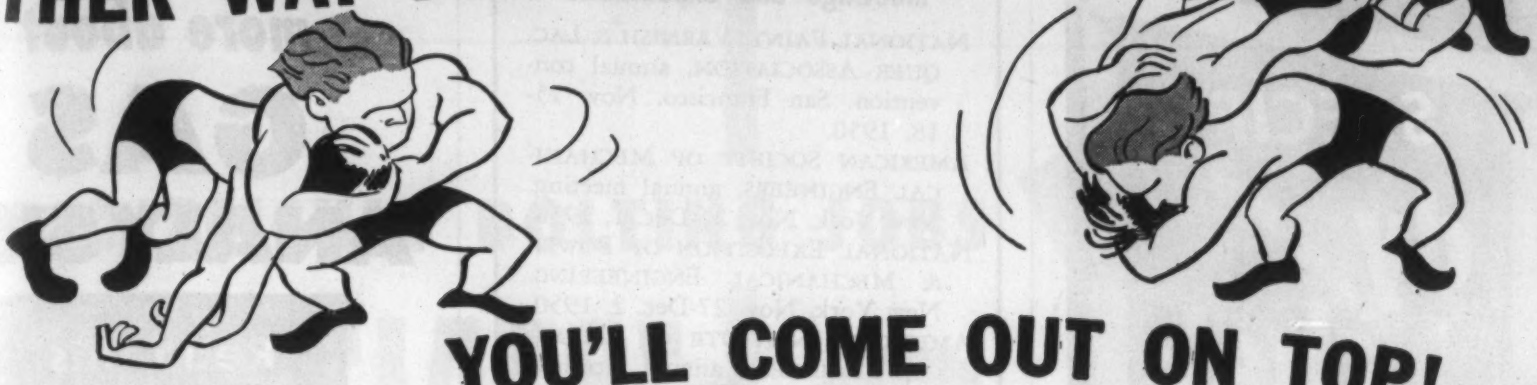

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b. 24-hour water absorption	Less than 0.5% by weight	Less than 0.5% by weight
Light in weight—specific gravity	1.05	1.05
Tensile in Psi	4,400	5,100

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Meetings and Expositions

NATIONAL PAINT, VARNISH & LACQUER ASSOCIATION, annual convention. San Francisco. Nov. 15-18, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. New York. Nov. 26-Dec. 1, 1950.

NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING. New York. Nov. 27-Dec. 2, 1950.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting. Columbus, Ohio. Dec. 3-6, 1950.

NATIONAL ASSOCIATION OF MANUFACTURERS, annual meeting. New York. Dec. 6-8, 1950.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Electric Furnace Steel conference, Iron & Steel Div. Pittsburgh, Pa. Dec. 7-9, 1950.

INSTITUTE OF THE AERONAUTICAL SCIENCES, Wright Brothers Lecture. Washington, D. C. Dec. 16, 1950.

PLANT MAINTENANCE SHOW AND CONFERENCE. Cleveland. Jan. 15-18, 1951.

SOCIETY OF PLASTICS ENGINEERS, INC., national conference. New York. Jan. 18-20, 1951.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland. Jan. 19, 1951.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Philadelphia. Jan. 22-26, 1951.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York. Jan. 29-Feb. 1, 1951.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. St. Louis. Feb. 18-22, 1951.

PITTSBURGH CONFERENCE ON ANALYTICAL CHEMISTRY & APPLIED SPECTROSCOPY. Pittsburgh, Pa. Feb. 28-Mar. 2, 1951.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting and committee week. Cincinnati. Mar. 5-9, 1951.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference and exhibition. New York. Mar. 13-16, 1951.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. New York. Mar. 15-17, 1951.

WESTERN METAL CONGRESS AND EXPOSITION. Oakland, Calif. Mar. 19-23, 1951.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace, Coke Oven and Raw Materials conference, Iron & Steel Div. Cleveland. Apr. 2-4, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Atlanta, Ga. Apr. 2-5, 1951.

ELECTROCHEMICAL SOCIETY, spring meeting. Washington, D. C. Apr. 8-11, 1951.

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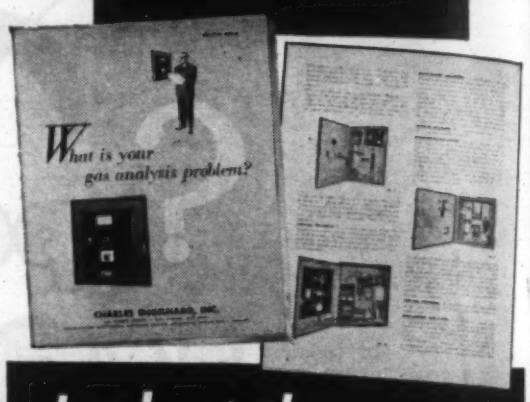

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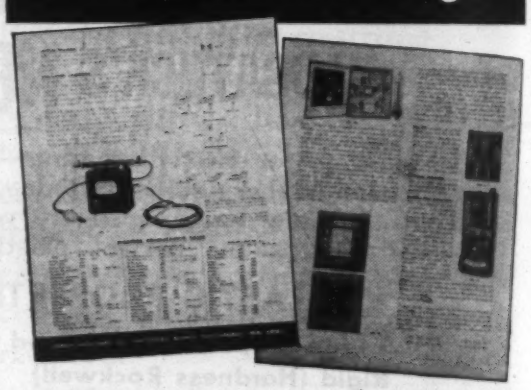

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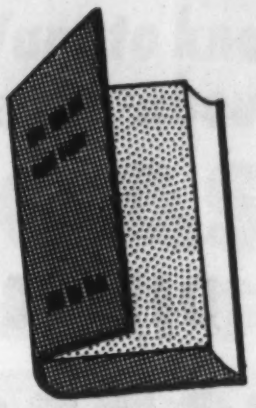

BOOK REVIEWS

Chemical Dictionary

THE CONDENSED CHEMICAL DICTIONARY, 4TH EDITION. *Revised and enlarged by Arthur and Elizabeth Rose; Francis M. Turner, editorial director. Published by Reinhold Publishing Corp., New York 18, N. Y., 1950. Cloth, 6½ by 9¼ in., 726 pages. Price $10.00.*

Like its predecessors, the new edition of this useful book is intended primarily to serve the needs of people not formally educated in chemistry or chemical engineering. For such personnel in the chemical and related industries, this new edition provides a short cut to a wealth of specific information about a vast number of commercial substances.

The new edition contains 5000 new entries, making a total of 23,000. There has been no attempt to produce an exhaustive work. Instead, the authors have limited themselves to essential information on properties and uses, with brief notes as to how substances are manufactured when they are not naturally produced, and data on standard containers, hazards and shipping regulations.

The number of entries covering chemical specialties, sold under trade marks or brand names, has been greatly increased in accordance with a recent trend toward this type of marketing by chemical manufacturers. Some of these products are just now ready to be placed on the market. In addition, there are many new items on fields, such as nuclear chemistry, chemotherapy, petrochemistry, etc. These new items cover products and processes which may as yet have no industrial applications but which are of scientific importance and wide general interest.

Other New Books

THE FRACTURE OF METALS. *Published by the Institute of Metallurgists, London, England, 1950. Paper, 5½ by 8½ in., 138 pages. Price 12/6d.* A series of lectures on the fracture of metals, delivered at the Institute of Metallurgists' Refresher Course, held in Sept. 1949.

A HISTORY OF STEEL CASTING. *Compiled and edited by Arthur D. Graeff. Published by District No. 1, Steel Founders' Society of America, 1949. Cloth, 6 by 9 in., 168 pages. Price $2.50, available from W. H. Worrilow, Lebanon Steel Foundry, Lebanon, Pa.* Importance of the steel casting industry as a significant contributor to industrial progress and economic welfare of the nation through the last century is emphasized in this book, prepared under the direction of William H. Worrilow, president of Lebanon Steel Foundry, and other industry leaders in the East.

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The Editor's Page

Now is the time to evaluate the recent trek to the Metal Show. Each year the Metal Show week seems to pass more slowly. Several outstanding memories will probably remain for some time—notably sore feet from traipsing through miles of aisles.

Each year we see fewer and fewer steel companies exhibiting in the show. This year there was only one left. Possibly this reflects the growing feeling that the Show should be held only every second year. Technical meetings of the four cooperating societies could still be held each year. The net result would probably be better attendance at all events.

New York cab drivers have long been noted as purveyors of thrilling rides. I for one, however, am in favor of handing the title to Chicago cabbies. On those round trips from the Stevens Hotel and the International Amphitheater my eyes were closed most of the time, for I didn't dare watch the narrow squeaks we had. To their credit I must state that we didn't even suffer a scratched fender, but how is still a mystery.

Possibly the subject of most interest in the Show was titanium. Two exhibitors were showing the latest material to get the glamor treatment. Speaking of glamor, attendance was built even more at one titanium exhibit by the ancient and honorable device of having a pretty blonde receptionist.

Since I was so close, I went through one of the big packing houses which border the stockyards. Although gory, the trip was interesting. Slaughtering animals and dressing meat is as mechanized as any of our industry. And as is well known, the scrap loss is less than in most metal working plants.

When stationed in our company booth, I had a chance to meet many readers of this magazine and to defend myself against some. Chief adversaries were those whose job it is to sell nickel. They referred to our recent article which stated that there evidently was almost enough nickel to go around. As punishment, one man suggested that I trade jobs with him for one month and try to find some of this available nickel.

Immediately upon leaving Chicago I thought I'd never want to again meet a steak head-on. That feeling has long since passed, however, and my mouth is watering just a bit.

Although feelings were mixed, there was a strong undercurrent of sentiment to the effect that many of the artificial materials shortages will soon disappear. At least the mad scramble for supplies will have passed. That is, until government orders snafu the situation again. Always with an eye to politics, certain governmental agencies countermand orders that might have provided some relief. An example is an industry suggestion that about 150 uses of aluminum could be outlawed, with a sizable savings in that metal. The NPA prepared to issue such an order, but it was stymied by the National Security Resources Board. Perhaps the policy is now war and politics as usual.

T. C. Du Mond
Editor